

वार्षिक रिपोर्ट ANNUAL REPORT 1997 - '98



CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

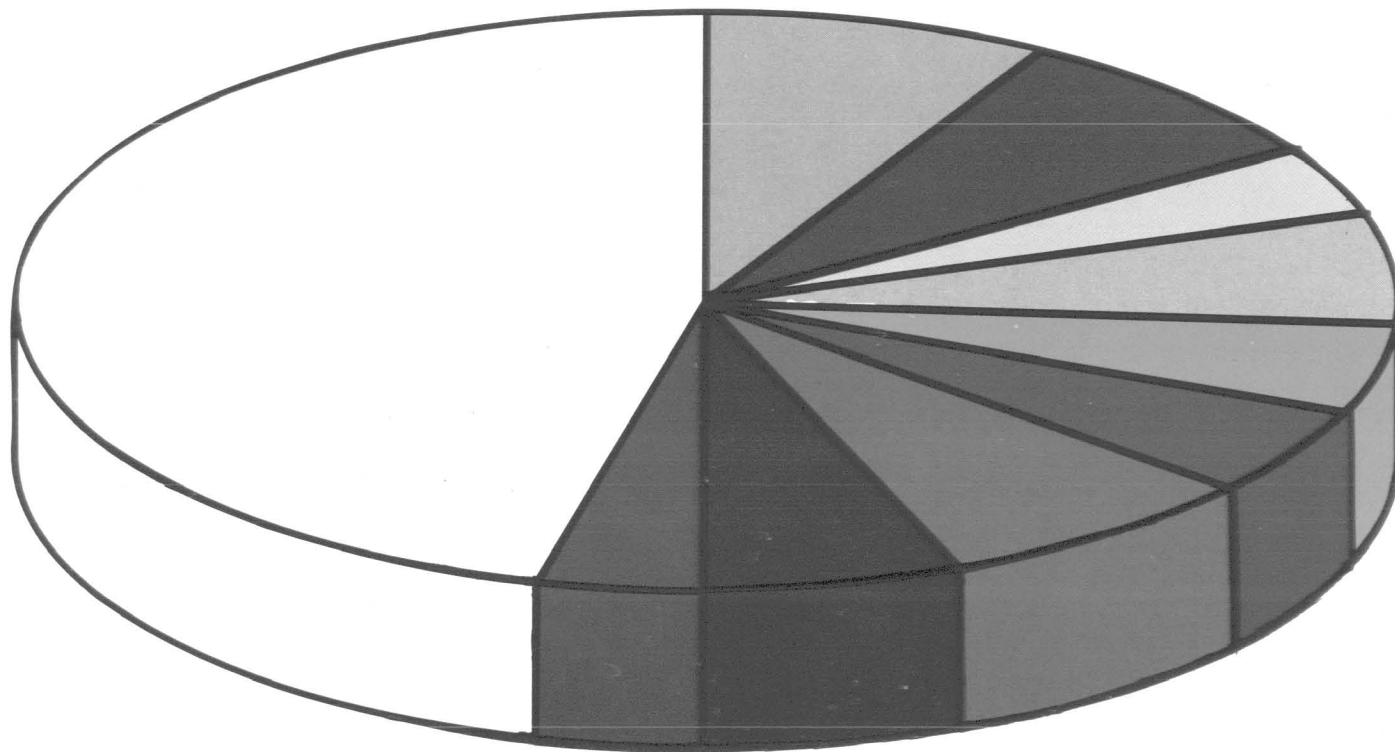
Indian Council of Agricultural Research

P.B. No. 1603, Cochin-682 014



MAJOR COMPONENTS OF MARINE FISH LANDINGS IN INDIA - 1997

(Total estimated landing: 2.69 mt)



Oil Sardine	Mackerel	B. duck	Perches	Carangids
Croakers	P. prawns	N.P.Prawns	Cephalopods	Others

ANNUAL REPORT 1997 - 1998



CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

Indian Council of Agricultural Research

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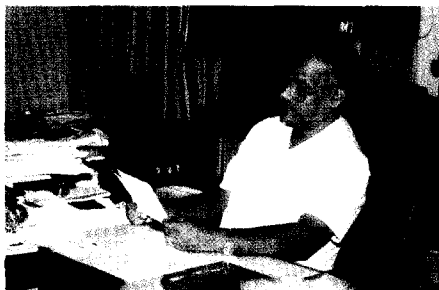
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PREFACE



The marine fisheries sector of India has, over the years, grown to the level of a major industry with a gross capital investment of around Rs 3350 crores and a gross annual income of about Rs 8000 crores (at the landing centre price level). This sector continues to be one of the major suppliers of protein food to the domestic as well as overseas markets. The income through marine products export has grown to the level of US \$ 1.3 billion (Rs 4700 crores) during 1997-98 accounting for 7% of the country's net foreign exchange earnings. About three million people in the country are dependant on seafishing directly or indirectly. And, the demand for seafish is growing steadily year after year. It is needless to stress that an industry of this magnitude receive strong research support to enable it to increase and sustain the returns.

The CMFRI, as during the past, continued its efforts in developing a sound database on all the exploited marine finfish and shellfish stocks through its own as well as externally funded projects, this year also. The programmes in mariculture of finfish and shellfish were further strengthened by augmenting the existing facilities and training the scientists in particular areas. Transfer of mariculture technologies was continued and considerable revenue was generated through consultancy and contract research. During the year, the Institute received external funding for 16 projects from within India and for 2 projects from abroad.

Under the postgraduate teaching programme at the Institute, a total of 11 candidates obtained M.F.Sc. degree and 7, the Ph.D. degree. Besides, 2 candidates submitted their theses for the Ph.D. degree and are awaiting the result.

The brief report presented in this publication reveals that the Institute has achieved the targets in all its spheres of activity. This could not have been possible without the whole-hearted involvement of my colleagues. I congratulate them for their achievements. I am particularly thankful to Dr. R.S. Paroda, Director General, ICAR for his continued support in the implementation of the Institute's programmes. Dr. K. Gopakumar, Deputy Director General (Fy), ICAR and Dr. R.A. Selvakumar, Assistant Director General (M.FY), ICAR have extended their cooperation and support in our endeavour. Dr. V. Sriramachandra Murty and Dr. N.G.K. Pillai prepared and edited the text of this report.

Cochin
June 1998



M. DEVARAJ
Director

EXECUTIVE SUMMARY

During the year, the CMFRI implemented 70 inhouse research projects besides 18 sponsored projects including 2 from abroad.

Database on exploited stocks

On the basis of the marine fisheries statistics collected from all along the Indian coast, the marine fish production during 1997 was estimated as 2.69 million tonnes which showed around 12% increase over 1996. Northwest coast contributed the maximum catch (37.9%) followed by southwest coast (30.8%), southeast coast (25.5%), northeast coast (4.5%) and Lakshadweep and Andamans (1.3%). Among the major marine fisheries resources of India, oilsardine registered increased production by 100%, Bombayduck by 12%, penaeid prawns by 8%, nonpenaeid prawns by 47% and catfish by 18%, over 1996. The mackerel registered a decline of 19% and threadfin breams 20%.

The menchained units accounted for 72% of the total marine fish landings followed by motorised (17.4%) and artisanal (10.6%) units.

The studies on the fishing fleet size in relation to the available stocks in the currently fished regions, revealed that among others, about 12245 trawl units, 835 purseseine units, 3972 mechanised gillnetters, 10746 outboard gillnetters and 31,000 nonmechanised units are adequate for obtaining optimum yields.

In the area of studying fishery and resource characteristics of exploited stocks, data on a large number of species of pelagic and demersal finfish, crustaceans and molluscs were collected.

In the case of sardine, purseseines, ringseines and bottom trawls were responsible for the major catch along the west coast whereas gillnetes, boatseines and bottom trawls were responsible for major catch along

the east coast. Oil sardine showed peak spawning during April-May along the west coast.

The seerfish showed a marginal decline in the landings in comparison to 1996; drift gillnet contributed over 56% of seerfish catch in the country.

Tuna production was over 46,000 tonnes during the year-the highest during the past 13 years and Kerala contributed 35% of the total tuna catch.

The peak spawning in mackerel occurred during June-July against the normal period of May-June apparently due to the delay in the onset of southwest monsoon. Large purseseines and ringseines with very small mesh exploited 2-3 month old mackerel which is undesirable.

There was about 67% increase in fishing effort for Bombayduck along Maharashtra which resulted in about 70% reduction in the landings; about 36% decline in the effort for this species along Gujarat coast resulted in an increase in the catch rate from 56 to 86 kg.

The increased importance of ribbonfish in the export market resulted in a record production of 1.7 lakh tonnes during 1977; Gujarat contributed 46% of the total ribbonfish catch in the country.

Most of the carangid species spawned during premonsoon period and towards the fag end of the southwest monsoon period.

Over 90% of the catch of elasmobranchs is landed by the trawlers and sharks formed about 67% of the elasmobranch landings. The major perches were exploited by trawl and hook & line.

Off Gujarat, *N. mesoprion* was most dominant at the beginning of the postmonsoon period with a catch

rate of 47 kg. At Cochin, maximum trawling effort was expended in January but maximum catch and catch rate of threadfin breams were obtained in September and the catch of *N. mesoprion* obtained during August and September accounted for 43% of the total threadfin bream catch in the year. Maximum sustainable economic yield of *N. japonicus* could be obtained by reducing the present effort by 20% off Karnataka.

Silverbelly landings in the Mandapam region were of the order of 26,000 t; October-November was the peak period of abundance in the Palk Bay and February-March in the Gulf of Mannar.

Maharashtra and Gujarat contributed to the bulk of the sciaenid catches and trawl was the principal gear. Along the Maharashtra coast, the peak spawning period for the dominant species was October and November.

For lizard fishes, October-January was the period of abundance along Gujarat, April, May and September along Maharashtra and July-September along Kerala, Tamilnadu and Andhra Pradesh.

In the case of Bull's eye, January-March is the period of abundance along the Gujarat and February-May along the Maharashtra.

The gillnets operating off Satapti (Maharashtra) landed peak catches of pomfrets during October - December with a catch rate of about 270 kg per unit.

Off Karnataka, the flatfish landings were at peak during January-March and November-December.

The landings of whitefish registered substantial increase over the previous year along Karnataka coast and the length range was 80-209 mm with mature fish being abundant during April-December.

The bottom trawling operations along different parts of the Indian coast exploited considerable quantities of inedible benthic fauna and juveniles of edible

finfish and shellfish which constituted 2-40% of trawl catch.

The penaeid prawn landing along the west coast increased by about 12% over the previous year. The recent changes in the trawling operations has resulted in increased landings of nonconventional resources along the coast of Kerala and Karnataka and some of them (*T. curvirostris*, *Solenocera* sp. *P. canaliculatus*, *P. semisulcatus*) support the fishery considerably. Along the east coast, the penaeid prawn production showed marginal increase over the previous year; smaller species gained prominence in the trawl fishery suggesting a beginning for replacing the larger penaeid prawn species.

Deepsea prawn catch off Tuticorin was estimated at 863 t (240 kg/E) which showed about 60% increase over the previous year.

About 95% of nonpenaeid prawn catch was obtained along Gujarat and Maharashtra coasts; 78% of the landings in Gujarat were taken by trawl and 95% by Do/net along Maharashtra.

The lobster fishery improved by 286 t over the previous year; Gujarat and Maharashtra accounted for nearly 70% of the landings. The total crab production was estimated at around 47,000 t with Gujarat, Tamilnadu and Kerala contributing to about 80% of the production.

The cephalopod production in the country was estimated at 1.2 lakh tonnes. The catch rates were very high along Maharashtra (400 kg/E) and Karnataka (150 kg/E). During April-December 97, about 1,50,000 chanks were exploited at Mandapam and Rameswaram.

Mariculture

At the Field Mariculture Laboratory Cochin, experiments on culture of *E. malabaricus* (Grouper) were conducted. Juveniles of average weight 136 g stocked in 5 ton FRP Tanks (4.9 sq m bottom area) in March

1996 attained an average wt of 2,900 g by February 98. Using these specimens, experiments on maturation and sex reversal are conducted. Similarly, the grouper *E. tauvina* stocked in silpalin-lined pond in March 97 at an average wt of 74 g attained an average wt 1770 g by March 98.

Laboratory-reared postlarvae of *P. semisulcatus* were stocked at the rate of 60,000 nos/ha (0.02 g av. wt.) in 3 ponds each of 0.25 ha at Mandapam and reared for 135 days; the males attained average weight of 13 g and females 18g.

The F1 and F2 generations of *P. pelagicus* obtained in 96-97 were further reared during the year. F2 generation males and females produced in January 97 have grown to 40 g and 50 g respectively in 126 days. One female F2 crab spawned in October 97 yielding 2.5 lakhs of viable Zoea; about 200 baby crabs were obtained from these Zoea. The same female spawned again in November (after 25 days of 1st spawning), yielding 2.3 lakh viable Zoea.

A total of 3.02 lakhs of pearl oyster seed was produced in the Tuticorin hatchery. About 34,000 edible oyster seed were reared in Korampallam creek after growing them till attaining 25 mm size. A total of 60,000 pearl oyster spat were supplied to farmers. Mussel farming technology was transferred to 66 rural women in Kerala. The experiments on abalone seed production suggest that they attain full maturity during full moon and new moon days. New designs of cages with radial and lateral pedestals were made for farming pearl oyster and mussels and fast growth of pearl oysters was observed in high density stocking pedestal cages. A total of 5.9 lakh seed was produced and reared at Tuticorin and about 4.5 lakh seed was reared in Tamil nadu.

In the tissue culture of pearl oyster, crystal formation by the epithelial cells of mantle was observed in *in vitro* condition. In the rearing of hatchery produced pearl oyster spat in the onshore condition, survival rate was

found to be ranging from 16 to 36%. About 10 lakhs of *Veliger* larvae were successfully transported to Mandapam and reared in FRP tanks for 3 months; about 14,000 spat of size range 6.1 - 10 mm were raised and transferred to Palk Bay for further rearing. The survival after 7 months was 79%. A pearl oyster hatchery, with a capacity of production of 28 million larvae and 2.8 million spat per run was developed at Mandapam.

Experiments using diets made of fermented mantis shrimp and wheat-bran for the postlarvae of *Penaeus indicus* revealed improved growth performance and relatively high carcass yields in 45 days. Vitamin-C above 1,500 ppm is found to be essential to prevent pathological manifestations of soft cuticle, reduced, malformed or atrophied gills.

Whitespot disease in shrimps was noticed in wild populations at Madras in January 98.

Monitoring fishery environment

The hydrographic parameters in the fishing grounds were monitored almost all along Indian coast. Higher levels of total ammonia were recorded in the estuarine waters during June-August; during the other months they were normal. The heavy metal levels were found to be within the permissible levels in the finfish and shellfish in Cochin backwaters. The oil contamination along 150 km long coast of Karnataka was observed to be due to residual fuel oils carried by oil tankers or similar sources. The paralytic shellfish poisoning which resulted in the death of seven persons along southwest coast was found to be due to cyanobacteria or dinoflagellates; there was heavy bloom of phytoplankton in the region during the period. A new approach using clams and oysters as bioindicators and coliforms as fecal pollution indicators was developed. Experiments on culture of agar yielding seaweeds under green house condition were continued at Mandapam; the material pretreated with 8 mg/l of ascorbic acid for 12hrs yielded 73% increase in biomass.

Technology transfer

In the programme of empowerment of coastal communities, 25 beneficiaries were given training in finfish culture. Under the programme of development of women and children in the rural areas, 11 beneficiaries were given technical advice and were also enabled financial support. Regular fishermen-farmers-scientists meetings were arranged and the fisherfolk were given technical advice.

Teaching and training

The Scientists of the institute spent about 3230 man-hours in teaching M.F. Sc. and Ph.D. programmes. A total of 11 candidates obtained M.F.Sc and 7, the Ph.D. degree. Under the Krishi Vigyan Kendra, 23 courses were conducted in different areas and 547 persons were trained. Under the Trainers' Training Centre, a total of 10 courses were conducted and 102 participants were given the required training in different areas of marine fisheries and mariculture.

INTRODUCTION

India is endowed with a long coastline of 8129 km, 0.5 million sq.km of continental shelf, 2.02 million sq.km of EEZ and an estimated annual marine fishery potential of 3.9 million tonnes. The vast areas all along the coastline offer ideal sites for seafarming and coastal mariculture. The Indian marine fisheries sector plays a very important role in supplying protein-rich food to the increasing population, employment generation and foreign exchange earning.

The present marine fisheries scenario is characterised by declining yields from the inshore waters, increasing conflicts between different resource users, increasing demand for fish food for domestic consumption and export and prospects for large scale seafarming and coastal mariculture. This warrants greater and more effective R&D efforts to enable implement suitable action plans for sustained marine fisheries and mariculture development. The Central Marine Fisheries Research Institute (established in 1947) is the nodal agency in India, responsible for Research support in marine fisheries development.

Over the period of nearly half a century since its inception, the CMFRI grew significantly in its size and stature and built up a fairly adequate research infrastructure and recruited suitably qualified R&D staff. The Institute's multidisciplinary approach to research in marine capture and culture fisheries has won the recognition as a premier Institute comparable to any well-established laboratory in the World.

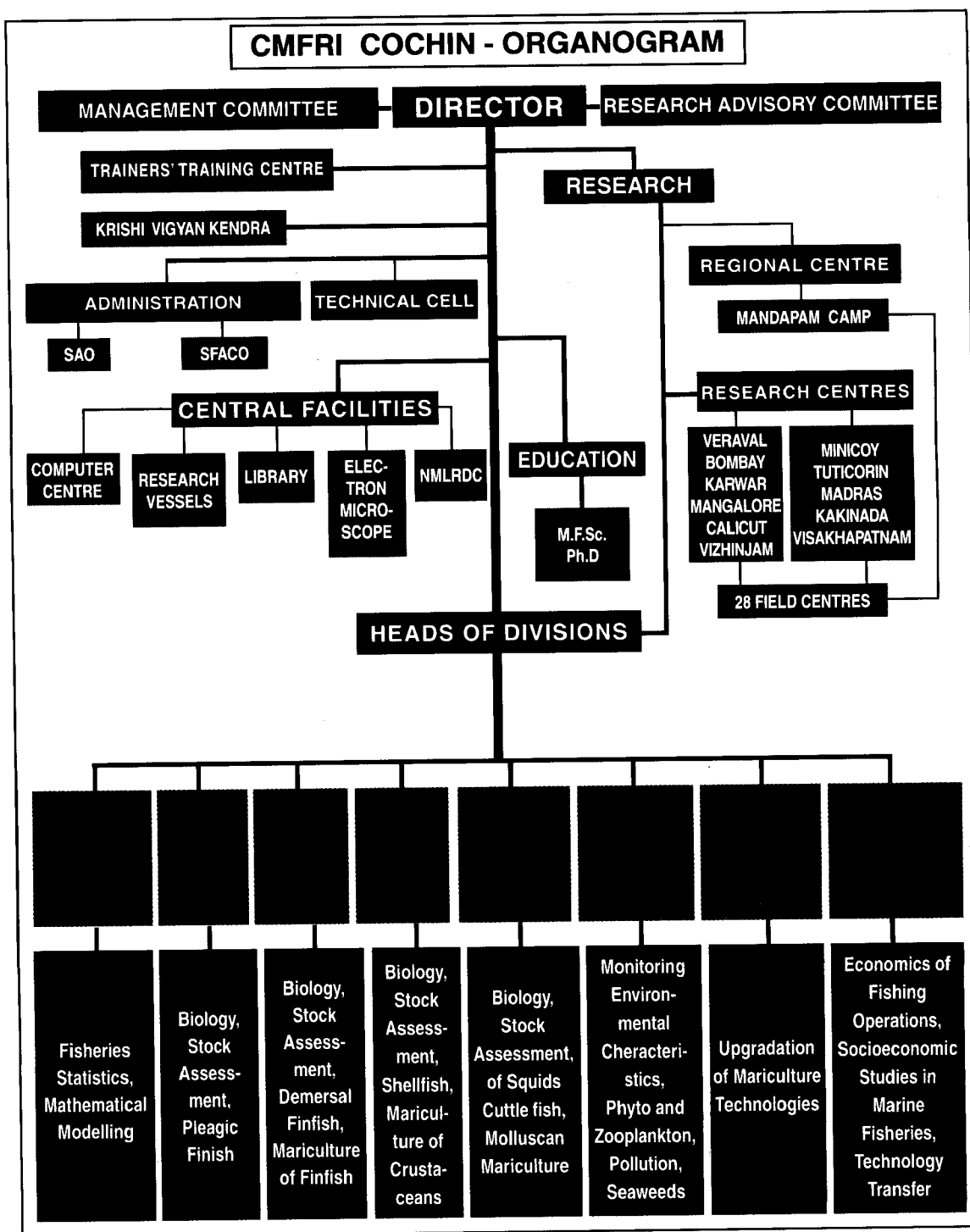
To accomplish its mandate, the Institute conducts researches on characteristics of exploited marine fish stocks; carries out exploratory surveys and assesses the under-and unexploited resources, develops seafarming techniques, undertakes research in fishery environmental characteristics and sea-dynamics and

conducts postgraduate education programmes. Besides, the Institute collects marine fisheries statistics and makes estimation of species-wise landings and monitors the landings on a continual basis from all along the country's coast. Studies are also conducted on economics of fishery enterprises and socio-economic conditions of fisherfolk.

The organisational setup

To be able to effectively carry out these tasks, the Institute has set up a Regional Centre at Mandapam Camp and Research Centres at Minicoy, Veraval, Bombay, Karwar, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Kakinada and Visakhapatnam and 28 Field Centres. The entire activity is coordinated by the Headquarters at Cochin. The Institute has, over the years, built up laboratory and field facilities including computers and research vessels for carrying out research programmes and has been upgrading the same to meet the changing and additional requirements. The sanctioned staff strength of the Institute is: Scientists 189, Technical 445, Ministerial 172, Supporting 296 and Auxillary 39.

The multidisciplinary researches in capture and culture fisheries are conducted under eight Divisions: Fisheries Resources Assessment, Pelagic Fisheries, Demersal Fisheries, Crustacean Fisheries, Molluscan Fisheries, Fishery Environment Management, Physiology, Nutrition and Pathology and Socio-economic Evaluation and Technology Transfer. Interdivisional and Interinstitutional programmes with collaborating agencies are carried out for greater utilisation of expertise and facilities. Besides, the Institute also takes up short-term research projects on important and priority areas sponsored by outside agencies in the country and offers consultancy services to the industry.



The Mandate

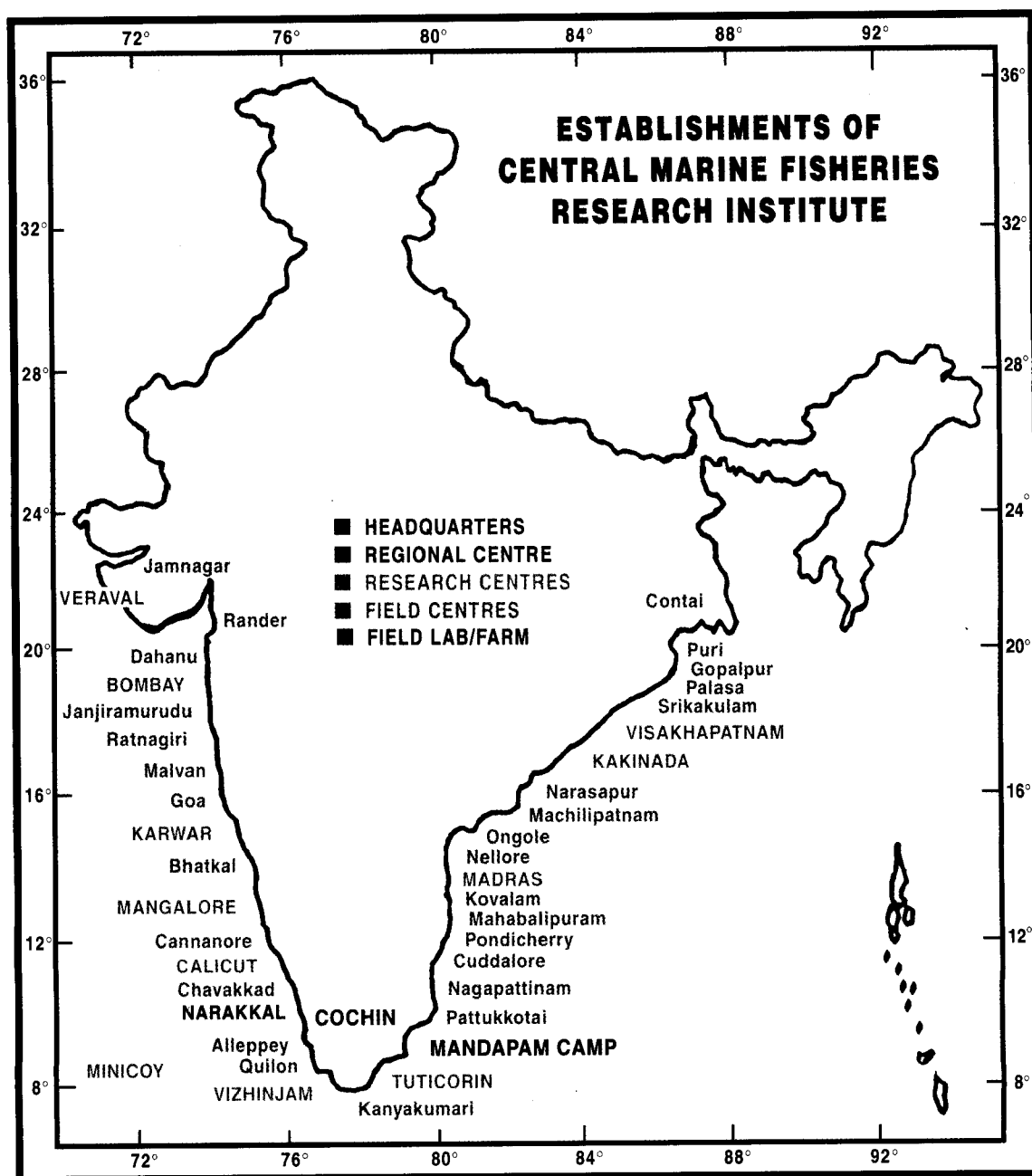
- ✱ Assessment and monitoring of the status of the exploited and unexploited fish stocks in the Indian EEZ, the contiguous international waters (for the mesopelagics) and the Southern Ocean (for Antarctic krill and finfish) in relation to fishery independent and fishery dependent factors; evaluation of the technoeconomics and socioeconomics of marine fishing operations.
- ✱ Development of suitable technologies for seafarming of finfish, shellfish, seaweeds and other cultivable marine organisms; evaluation of the technoeconomics and socioeconomics of mariculture operations; upgradation of technologies through R&D in frontier areas in Biotechnology, Nutrition, Pathology and Endocrinology.
- ✱ Monitoring the health of the coastal ecosystems, particularly the endangered ecosystems in relation to artisanal fishing, mechanised fishing and marine pollution.
- ✱ Transfer of viable seafarming technologies through extension education, specialised trainings and consultancy services.
- ✱ Postgraduate education in marine fisheries and mariculture leading to M.F.Sc and Ph.D degrees; introduction of new subjects in frontier areas and establishment of another Deemed University in Fisheries.

Under the Postgraduate Programme in Mariculture, the Institute organises M.F.Sc. and Ph.D. programmes under affiliation to the Central Institute of Fisheries Education - a Deemed University under the ICAR. The teaching programme is carried out by the Scientists of the Institute.

The Krishi Vigyan Kendra and the Trainers' Training Centre, impart training in mariculture, agriculture, animal husbandry and other related subjects to fish farmers, agricultural farmers and farm women and

the Trainers' Training Centre to officials of State Governments, Banks, Societies and autonomous bodies interested in fisheries development.

The Library and Documentation section provides reference facilities to research staff and students of the Institute as well as to visiting scientists both within and outside the country. The results of researches carried out in the Institute are published in various Journals. Besides, the Institute brings out Bulletins Special Publications and Marine Fisheries Information Service.



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BUDGET 1997-98

(Rs. in lakhs)

Budget Heads	Non Plan		Plan	
	Revised Estimates	Expenditure	Revised Estimates	Expenditure
Establishment Charges	900.80	900.80	—	—
O.T.A	1.20	1.20	—	—
T.A.	10.00	10.00	12.00	12.00
Other charges	70.00	44.39	160.00	168.35
Works	3.00	28.55	100.00	90.65
Other items	—	—	10.00	11.00
Total	985.00	984.94	282.00	282.00
	K.V.K.		T.T.C.	
Establishment charges	9.00	9.00	7.00	4.78
T.A.	0.30	0.26	0.30	0.27
Other charges	1.30	1.11	1.60	1.57
Works	—	—	18.00	18.00
Total	10.60	10.37	26.90	24.62

Library and Documentation Section

During the period under report 227 books and 1484 journals were added to the library at headquarters. Essential books and periodicals were also acquired for the libraries at the Regional Centre and Research Centres. Inter-library collaboration with inter-library loan of publications was continued. Reference facilities were provided to visiting Scientists, Scholars and Students of various Universities, institutions and others from within and outside the country.

The Library also stocks and distributes the Institute publications.

The following publications were issued:

1. *Indian Journal of Fisheries* Vol. 43 No. 4, Vol. 44 Nos. 1-3
2. *Marine Fisheries Information Service T&E Ser.* Nos. 146-151
3. CMFRI Special Publication:
 - (i) Transportation of live finfishes and shellfishes (No. 66)
 - (ii) Status of research in marine fisheries and mariculture (Role of CMFRI) (No. 67)
4. CMFRI Newsletter No. 72, 73, 74, 75, 76, 77 & 78
5. CMFRI Annual Report 1996-97
6. Research Highlights 1996-97

Vessel Management Cell

Arrangements for the major repair and overhauling of Cadalmin-VI of Vizhinjam has been made with a Kerala State Govt. Undertaking (KSINC). Cadalmin-IV at Tuticorin was in the sea for 19 days and is laid up in August for repair.

Action for the decommissioning and disposal of R.V. Skipjack has been taken. The Cell has rendered administrative support in the implementation of the FORV *Sagar Sampada* based projects funded by DOD.

Proposal for procurement of a new vessel jointly by CMFRI and CIFT has been

finalised and forwarded to the Council for approval.

VMC has extended facilities for the trial of newly fabricated trawl nets of CIFT onboard Cadalmin-IX. Also launched the longline in the open sea for oyster culture off Narakkal by the MFD and provided daily supply of seawater to all the Divisions for mariculture experiments.

The Official Language Implementation Programme

During the year under report, the Official Language Implementation Committee meetings were held regularly and the decisions implemented. The targets on Hindi correspondence especially the cent percent target on section 3(3) documents were fulfilled. Besides, ensured the bilingual usage in stationery items especially identity cards, forms, name plates of vehicles, codes and manuals etc. Institute's publications such as *Marine Fisheries Information Service* and Newsletter were issued in bilingual. Organised extension activities like Hindi Fortnight celebration and Hindi Workshops. Took follow-up action on the inspection report of Committee of Parliament on Official Language and co-ordinated the Hindi activities at the Research Centres.

Special efforts of the year

Release of Rajbhasha Circular

A bimonthly periodical containing self teaching lessons and competition corner as routine items was started from the Institute on 21-5-1997.



Shri K. B. Pillai, Chairman MPEDA, Dr. P. P. Pillai, Principal Scientist CMFRI and Prof. P. V. Vijayan, Head of the Dept. of Hindi (Retd.), CUSAT, at the Inaugural Function of Scientific Hindi Seminar. Dr. G. Sudhakara Rao, Head CFD of CMFRI welcomed the participants and invitee

Abstract of Theses in Hindi

During the year 8 M.F.Sc. students of the Institute submitted the abstract of their Theses in Hindi.

Conduct of Hindi classes

At the Mandapam Regional Centre, Tamil Nadu, CMFRI has started classes of Hindi Teaching Scheme in July 1997.

10% target on noting

In order to follow the new target in the Annual Programme 1997-98, selected phrases on correspondence on the file covers for reference were printed.

Organisation of farmers meet in Hindi

During the year, the Bombay and Veraval Research Centres have been identified for conducting the farmers' meet in Hindi. At the Veraval Centre the Krishak melas were organised and also meetings and discussions on culture, sampling and official correspondence were held in Hindi for the students of local Colleges. Similar activities were organised at the Bombay Centre too in which 71 fishermen actively participated.

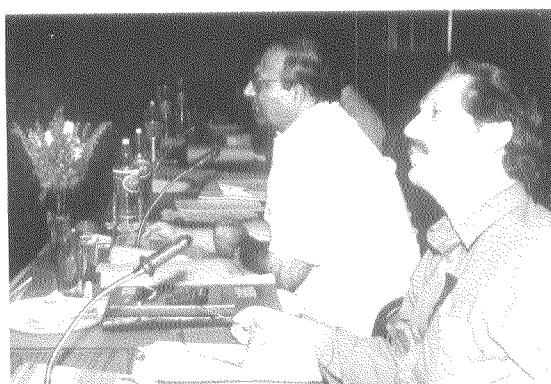
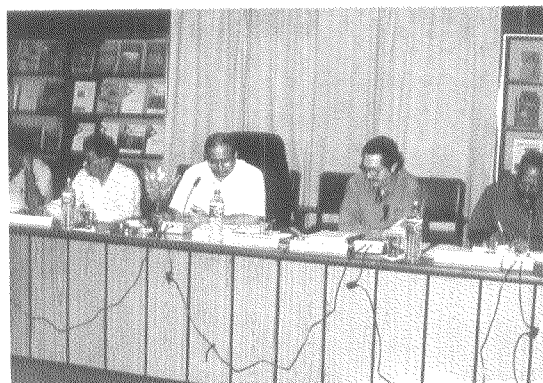
Scientific Seminar in Hindi

A one day Hindi Seminar on "Changing scenario in Marine Fisheries and New Dimensions" was conducted at headquarters and the proceedings was released in Hindi.

ICAR Governing Body Meeting

The Institute hosted the 175th meeting of the Governing Body of the ICAR Society during October 9-10, 1997. Dr. M. Devaraj, Director, made a presentation on the "Status of Research in Marine Fisheries and Mariculture - Role of CMFRI" on the occasion.

The DG and members of the governing body of ICAR at the meeting in CMFRI



RESEARCH ACHIEVEMENTS

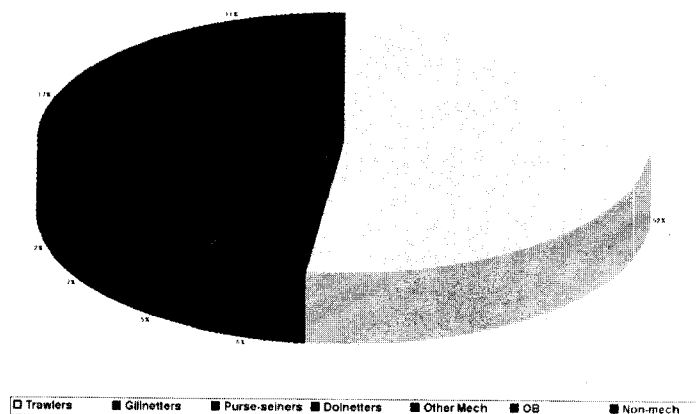
I. FISHERY RESOURCES ASSESSMENT DIVISION

ASSESSMENT OF EXPLOITED MARINE FISHERY RESOURCES (FSS/FRA/1.1)

K.Balan, K.N.Kurup, K.S.Scariah, M.Srinath and K.Vijayalekshmi

Marine fish production in India during 1997

The marine fish production in India during 1997 was provisionally estimated at 2.69 million tonnes(mt)



Contribution of different categories of fishing crafts to the marine fish production in India during 1997

which is 11.6% higher than the estimated production of 2.41 mt during 1996. The pelagic groups formed about 51.7% of the total landings and the demersal finfish, crustaceans and molluscs together formed 48.3%. The landings by the mechanized and motorized units together accounted for about 89.4% of the total landings.

The salient features of marine fish landings in the country during 1997 in comparison to 1996 are:

- * the oilsardine recorded a more than 100% increase with the estimated landing at 2,22,000 t
- * 12% increase in the Bombayduck landings with the estimated catch at 1,03,000 t
- * 18% increase in the catfish landings with annual estimated landing at 43,000 t

* 20% decline in the thread-finbream landings, the estimate for 1997 being 72,000 t.

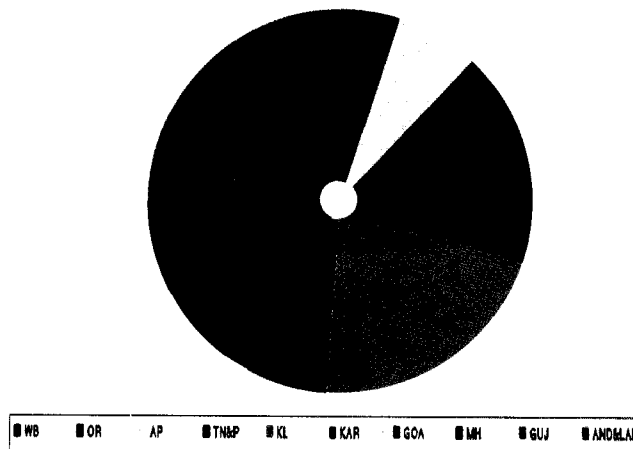
* the nonpenaeid prawn landings increased by about 47% with the estimated landing at 1,54,000 t

* the penaeid prawn catch increased by about 8% with the current year landing at 2,03,000 t

REGIONWISE LANDINGS

Northeast region: The landings registered a decline of about 8,000 t over the previous year. The principal components (with the estimated landings in parantheses) were *Hilsa* shad (27,000 t), catfishes (8,600 t), Bombayduck (6,000 t), croakers (16,000 t), pomfrets (5,600 t), penaeid prawns (6,000 t) and nonpenaeid prawns (2,500 t).

When compared to the previous year, *Hilsa* shad registered an increase of 3,300 t, the catfishes 600 t and pomfrets 300 t; croakers registered a decline of 3,700 t,



Contribution of different states to the all India marine fish landings in 1997

Regionwise marine fish production in India during 1997

Region	Estimated production (tonnes)	% in the all India total
1. Northeast (West Bengal & Orissa)	1,20,614	4.5
2. Southeast (Andhra Pradesh, Tamil Nadu & Pondicherry)	6,87,138	25.5
3. Southwest (Kerala, Karnataka & Goa)	8,28,686	30.8
4. Northwest (Maharashtra & Gujarat)	10,18,526	37.9
5. Lakshadweep & Andamans	33,804*	1.3

* Provisional

penaeid prawns 1,400 t, and non penaeid prawns 1600 t.

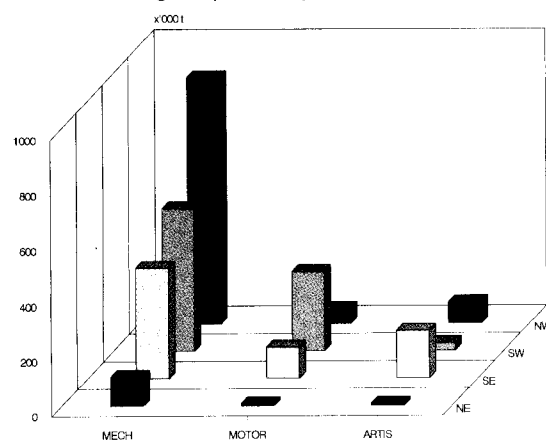
Southeast region: The estimated landing in 1997 from this region was 6.87 lakh t; an increase of 68,600t (11.1%) over the previous year. An estimated 111,500t of oilsardine was landed in 1997 which showed an increase of 41,000 t from 1996. However, the lesser sardines increased marginally by about 900 t from about 80,000t during the previous year. Perch landing

was estimated as 39,800 t, which was about 4,000 t less than that of the previous year. The landings of croakers declined by about 1,000 t from about 21,000 t during 1996. An increase of about 1,600 t was observed in the landings of ribbonfishes from about 11,000 t during the previous year. The landings of silverbellies increased from about 50,000 t during 1996 to about 53,000 t in 1997. Unlike in the west coast, there was an increase in the landings of the mackerel from about 28,000 t in 1996 to about 39,000 t during 1997. The landings of penaeid prawns decreased to about 42,000t during this year from about 43,000 t during 1996. A significant decrease was noticed in the landings of the cephalopods from about 19,000 t in 1996 to about 12,000 t during this year.

Southwest region: The landings increased by about 36,000 t over the previous year. The most significant feature in this region is that the oilsardine landings (1,11,000 t) increased by 192% over those of the previous year and the mackerel fishery registered decline. The landings of threadfin breems declined from about 61,000 t in 1996 to about 25,000 t in 1997, carangids from about 87,000 t to 73,000 t and whitebait from about 34,000 t to 31,000 t. The landings of penaeid prawns increased by about 12,000 t from about 56,000t during the previous year. The estimated stomatopod landings (53,000 t) were about 23,000 t more than those in the previous year. The cephalopod landings increased from about 41,000 t in 1996 to about 51,000t during 1997.

Northwest region: This region contributed the maximum to the total landings in the country with the estimated landings at 10.2 lakh t as against 8.50 lakh t during 1996.

The landings of Bombayduck and nonpenaeid prawns showed significant increase of 17,500 t and 50,000 t over the previous year respectively. Similar increase was observed in the case of ribbonfish from about 83,000 t in 1996 to 122,000 t during 1997. The penaeid prawns registered an increase of about 6,000 t during the year. The cephalopod landing was estimated at 50,000 t during this year which was about 3,000 t more than that in 1996.



Regionwise marine fish landings in different sectors during 1997

ESTIMATED FISH PRODUCTION (TONNES) IN INDIA DURING 1996 AND 1997.

Name	1996	1997	Name	1996	1997
PELAGIC FINFISH			SHELLFISH		
CLUPEOIDS			CRUSTACEANS		
Wolf herring	14341	17798	Penaeid prawns	188060	203401
Oil sardine	110346	223879	Nonpenaeid prawns	104462	153923
Other sardines	106924	120627	Lobsters	2631	2887
<i>Hilsa</i> shad	25648	28889	Crabs	29049	45770
Other shads	7981	10457	Stomatopods	72342	93084
<i>Coilia</i>	30986	33513	MOLLUSCS		
<i>Setipinna</i>	2316	2871	Cephalopods	107071	113855
<i>Stolephorus</i>	61392	57479	Total shellfish	503615	612920
<i>Thrissina</i>	146	19	DEMERSAL FINFISH		
<i>Thryssa</i>	37944	45137	ELASMOBRANCHS		
Other clupeoids	60126	51596	Sharks	34750	42777
BOMBAYDUCK	91657	102832	Skates	2132	3426
HALF BEAKS & FULL BEAKS	3783	4005	Rays	21752	27052
FLYING FISHES	997	173	EELS	7030	7649
RIBBON FISHES	126905	169647	CATFISHES	36090	42762
CARANGIDS			LIZARD FISHES	30055	20528
Horse Mackerel	17652	18391	PERCHES		
Scads	66790	38342	Rock cods	14688	15188
Leather-jackets	5176	7152	Snappers	4258	5285
Other carangids	57760	74023	Pigface breams	12104	14234
MACKERELS			Threadfin breams	90705	72149
Indian mackerel	275677	223937	Other perches	46139	49827
Other mackerels	17	18	GOATFISHES	10407	11253
SEERFISHES			THREADFINS	8832	9142
<i>S. commerson</i>	24613	23360	CROAKERS	161080	147838
<i>S. guttatus</i>	12662	13255	SILVERBELLIES	62003	65996
<i>S. lineolatus</i>	96	901	BIG-JAWED JUMPER	6523	7466
<i>Acanthocybium</i> spp	23	21	POMFRETS		
TUNAS			Black pomfret	12433	13260
<i>E. affinis</i>	14778	23425	Silver pomfret	22834	30736
<i>Auxis</i> spp.	11119	10564	Chinese pomfret	515	865
<i>K. pelamis</i>	1225	1888	FLATFISHES		
<i>T. tonggol</i>	4263	5322	Halibut	3516	2504
Other tunas	9535	5267	Flounders	99	154
BILLFISHES	3889	4448	Soles	37746	48654
BARRACUDAS	14476	13372	MISCELLANEOUS		
MULLET	6198	5603	Total Demersal finfish	663192	681208
Total Pelagic finfish	1247842	1386585	Grand Total	2414649	2680713

**Percentage contribution of different regions
to the landings by each category of units during 1996 and 1997**

	1997			1996		
	Mech.	Motor.	Arti.	Mech.	Motor.	Arti.
Northeast	5.53	1.66	2.58	6.68	0.04	6.51
Southeast	20.95	24.66	61.25	20.85	23.39	74.21
Southwest	26.97	62.14	9.47	26.37	68.51	14.21
Northwest	46.57	11.54	26.70	46.10	8.06	5.07

Mech. - Mechanized, Motor. - Motorized, Arti - Artisanal

**Percentage contribution of different categories of units to the production
from each region during 1996 and 1997**

	1997			1996		
	Mech.	Motor.	Arti.	Mech.	Motor.	Arti.
Northeast	87.60	6.36	6.04	89.37	0.15	10.48
Southeast	58.27	16.54	25.19	58.09	17.01	24.90
Southwest	62.20	34.57	3.23	57.37	38.91	3.72
Northwest	87.37	5.22	7.41	94.44	4.31	1.25

Landings by Mechanized, Motorized and Artisanal units

The landings of 19.1 lakh t by the mechanized units accounted for about 72.0 % of the total marine fish landings of the country during 1997 followed by the

motorized (17.4%) and artisanal units (10.6%). Trawl net, purseseine, gillnet and do/net were used by the mechanized units, ringseine and gillnet by motorized sector and gillnet, shoreseine, boatseine and several others by the the artisanal sector.

**EVALUATION OF CHANGE IN THE PATTERN OF CATCH AND COMPOSITION OF
MARINE FISHERY RESOURCES IN INDIA**

(FSS/FRA/1.19)

K.S. Scariah, K.N.Kurup, K. Balan, M.Srinath and K. Vijayalekshmi

The preparation of reports on marine fisheries appraisal in respect of Karnataka, Andhra Pradesh, Goa and

Gujarat is in progress.

MANAGEMENT INFORMATION SYSTEM IN MARINE FISHERIES (FSS/FRA/ST.1)

K.N. Kurup, K. Balan, K.S. Scariah, M.Srinath and K. Vijayalekshmi

The marine fishery data collected during April '97 to March '98 were computerized. The data were backed up on magnetic tapes and tape cartridges.

The various endusers were provided with necessary data.

STOCK ASSESSMENT TECHNIQUES IN MARINE FISHERIES RESEARCH AND MANAGEMENT (FSS/FRA/1.3)

M. Srinath and K.N. Kurup

During this year, the optimum fleet size for different types of gear-craft combination was estimated for each maritime state, based on the trends in the catch, the corresponding effort and the catch rate by the respective gear-

craft combination over the last one decade. The results reveal that in most of the states, the fishery is operating well beyond the estimated optimum levels, indicating the need for proper allocation of the effort.

Estimated Optimum Fleet Size

State	MTN	PS	MGN	MBN	MOTHS	OBBS	OBGN	OBRS	OBDOL	OBOTHS	NM	TOTAL
West Bengal	88	0	11	193	77	0	372	0	0	0	391	1132
Orissa	436	0	383	0	715	0	35	0	0	113	1584	3266
Andhrapradesh	599	0	540	0	18	4	635	0	0	177	8481	10454
Tamilnadu	3163	0	1781	7	703	96	3227	0	0	888	12695	22562
Pondicherry	74	0	69	15	6	0	252	0	0	39	1227	1683
Kerala	3275	29	77	0	20	222	3255	1258	0	2014	5159	15310
Karnataka	1057	378	15	0	1	1	299	44	0	85	328	2210
Goa	284	289	36	0	2	0	252	0	0	22	74	959
Maharashtra	1627	138	581	893	93	0	450	0	6	127	395	4311
Gujarat	1643	0	479	1084	47	0	1968	0	153	0	725	6099
TOTAL	12245	835	3972	2193	1683	326	10746	1302	159	3465	31058	67985

No. of expected days of operations

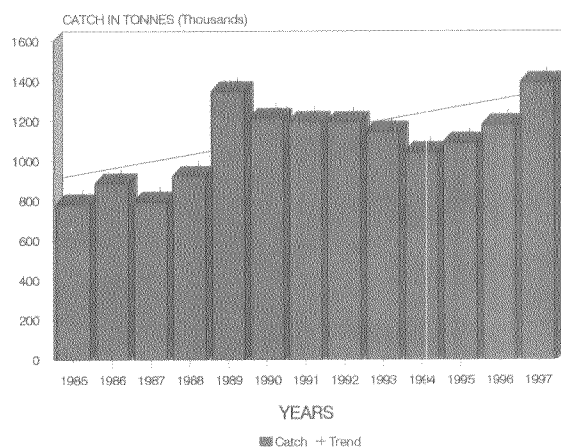
180 120 150 150 150 200 200 200 200 200 200

MTN = Mech. trawlers; PS = Purse seiners; MGN = Mech. Gillnetters; MBN = Mech. Bag Netters; MOTHS = other mechanised; OBBS = Outboard Boat seiners; OBGN = Outboard Gillnetters; OBRS = Outboard Ring seiners; OBDOL = Outboard dol netters; OBOTHS = Outboard others; NM = Nonmechanised.

II. PELAGIC FISHERIES DIVISION

During 1997-98 Pelagic Fisheries Division undertook 8 Research Projects on fishery and resources characteristics of sardines, anchovies, seerfishes, tunas, tuna live-baits and billfishes, mackerel, Bombayduck, ribbon-

fishes and carangids. Pelagic finfish landings during the last 13 years varied from 0.78 million t in 1985 to 1.35 million t in 1997; forming 51.4% of the total fish production. A stagnation in the catch at around 1.3 million t against an annual potential yield of 2.21 million t of pelagic resources from the Indian EEZ could be observed for the last 8 years. About 67.6% of the pelagic finfish production in 1997 was obtained from the west coast while 30.8% from the east coast and the rest (1.6%) from the Island territories. Among the maritime states, Kerala contributed 26% followed by Gujarat 19%, Tamil Nadu 18.5%, Maharashtra 11.5% and the rest from other states.

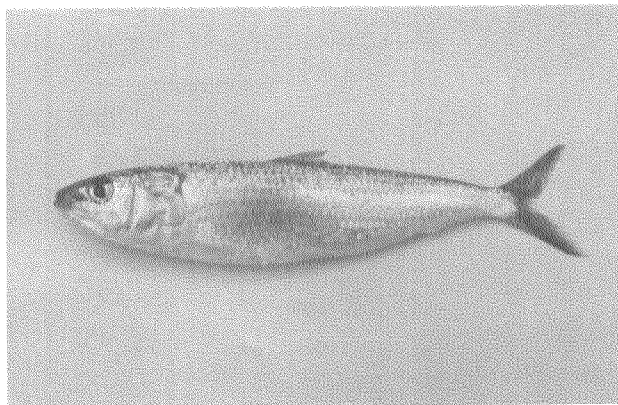


All India Pelagic Fish Landings (1985-97)

FISHERY AND RESOURCE CHARACTERISTICS OF *SARDINELLA* SPP. (PF/RE/1.1)

N.G.K.Pillai, U.Ganga, Prathibha Rohit, T.M.Yohannan, A.A.Jayaprakash, H.Mohammed Kasim and K.Dorairaj

The oil sardine fishery after its drastic decline to 47,000 t in 1994 showed signs of resuscitation and the current production is 2.22 lakh t. The production during the last 13 years varied from 0.47 lakh t in 1994 to 2.79 lakh t in 1989. The catch after the peak in 1989, showed a gradual reduction till 1994 and slowly increased subsequently. Kerala, which was the major contributor till 1993, was slowly relegated and in 1997 it became the major contributor, 93,636 t (42.2%) followed by Tamil Nadu (30.4%), Andhra Pradesh (13.9%), Karnataka (4.4%), Goa (3.5%) and



Sardinella longiceps

the rest from other states. Lesser sardine production showed a steady progressing trend and the catch ranged from 0.6 lakh t in 1985 to 1.3 lakh t in 1995 with the present catch at 1.2 lakh t. The major contributor in 1997 was Tamil Nadu (52%) followed by Kerala (13.3%) and Andhra Pradesh (12.9%).

The fishery and resource characteristics of *Sardinella* spp. exploited by the different gears were monitored at Karwar, Mangalore, Calicut and Cochin along the west coast and Tuticorin, Mandapam, Madras and Visakhapatnam along the east coast.

Increase in the sardine catch was observed at all the centres except Tuticorin. The purseseines, ringseines, bottom trawls and indigenous gears mainly exploited sardines on the west coast compared to gillnets, boatseines and bottom trawls along the east coast.

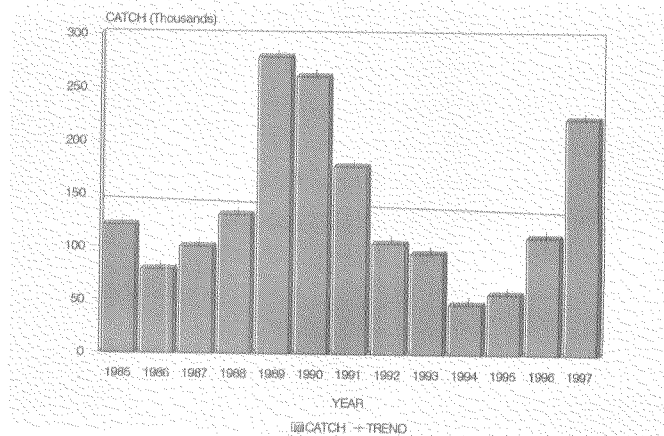
At Karwar, the entire sardine catch of 8,044 t was from the purseseines, forming 46% of total catch in the gear. The catch at Mangalore-Malpe was 7,919 t. The purseseines contributed 7,484 t (94.5%), trawls (4.7%) and *rani bale* the rest. At Calicut the *Chala vala* (3.3 t), the ringseines (501 t) and trawls (11.5 t) contributed to the sardine catch. At Cochin the purseseines, followed by ringseines and trawls brought 1256 t, 555 t and 32 t of sardines respectively. At Tuticorin the total catch was 2759 t contributed by non-mechanised gillnets (2128 t) and mechanised units (631 t). The trawlers at Rameswaram and Pamban realised 3826 t compared to 161 t exploited by the gillnets at Pamban. At Madras 3,550 t of sardines were landed by *Edavala* (76.1%), *Kavala vala* (23.7%) and *Podivala* (0.2%). A total of 232 t were landed by the gillnets (82.7%), trawls (9.9%) and boatseines (7.4%) at Visakhapatnam.

The purseseine landings at Karwar indicated that the sardine catch increased

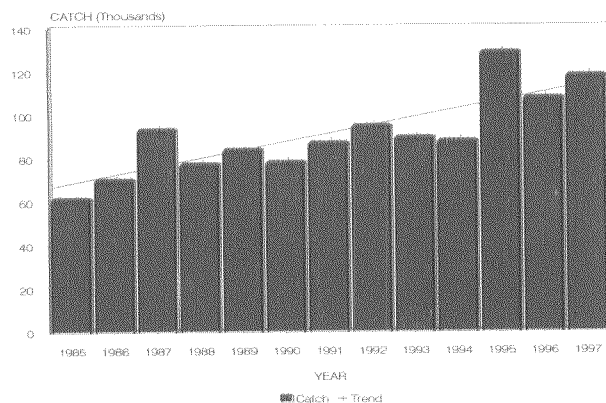
from 144 t in the last year to 8,044 t (+55 fold) in 1997. At Mangalore the gear recorded 2.9 fold increase from 2617 t to 7484 t compared to a 10 fold increase from 125 t to 1256 t at Cochin. In the ringseines the catch increased by 3 fold from 157 t to 500 t at Calicut compared to a 9 fold increase from 59 t to 555 t at Cochin. The trawls registered a 12 fold increase from 30 t to 369 t at Mangalore and by 3.8 times at Cochin from 8.3 t to 32 t, but the catch plummeted from 108 t to 12 t in 1997 at Calicut. On the east coast, at Tuticorin, the catch decreased from 1,149 t to 631 t in the mechanised gillnets and from 294 t to 213 t in the non-mechanised units.

The highest C/E of 1,250 kg was in the purseseines at Karwar compared to 472 kg at Cochin and 411 kg at Mangalore-Malpe. The remained around 200 kg in the ringseines at Cochin and Calicut. At Tuticorin the non-mechanised units realised a higher C/E of 95 kg compared 49 kg in the mechanised units. At Rameswaram the trawlers recorded a C/E of 85-97 kg compared to 73 kg in the gillnets. At Visakhapatnam also the gillnets with a C/E of 39 kg dominated over trawls and boatseines.

Oil sardine, *S. longiceps* was the dominant species in the purseseines and indigenous gears at Mangalore; in the ringseines and *Chala vala* at Calicut;



All India landings (t) of oil sardine (1985-97)



All India landings (t) of lesser sardines (1985-97)

in the ring seines, trawls and purseseines at Cochin; in all the gears (68-100%) at Madras; and in the boatseines at Visakhapatnam. Lesser sardines like *S. fimbriata* (47%) followed by *S. gibbosa* (32%) dominated the purseseine catch at Karwar. In the trawlers at Mangalore *S. gibbosa* (38%) and *S. fimbriata* (33%), and at Calicut *S. gibbosa* (76%) dominated. Nearly 65-80% of the gillnet catch at Tuticorin was composed of *S. gibbosa* compared to 4-10% contributed by the oil sardine.

Oil sardine in the purseseines had a size range of 120-180 mm at Karwar, 105-200 mm at Mangalore, 100-210 mm at Malpe and 110-200 mm at Cochin. The ringseine catch was composed of 80-205 mm at Calicut compared to 125-200 mm at Cochin. Oil sardine from *Edavala* had a size range of 80-110 mm with mode at 95 mm, compared to 130-160 mm (mode 130 mm) obtained in *Kavala vala*. At Malpe the trawlers exploited 150-180 mm compared to 135-140 mm at Visakhapatnam. Among the lesser sardines *S. fimbriata* of 140-160 mm, *S. gibbosa* 90-180 mm and *S. albella* 90-120 mm were recorded at Malpe. At Tuticorin, *S. gibbosa* of 80-135 mm and at Mandapam 95-155 mm were observed. *S. albella* had a

size range of 90-140 mm both on the east and west coast.

In the purseseines at Mangalore and Karwar females dominated among the pre-adults compared to males at Malpe and at Cochin. But among the adults the females were dominant in the ringseine catch on the west coast. At Visakhapatnam the females dominated in the boatseine and gillnet catches whereas males were predominant in trawl catches. Females outnumbered males in the lesser sardines at Rameswaram and Pamban and the sex ratio was statistically significant.

The dominant size groups that supported the fishery of oil sardine on the west and east coast were 140-190mm with slight variation between centres, except at Calicut where the ring-seines mostly exploited 85-135mm size groups. This was mostly as a result of the incursion of the young ones into the fishing grounds at Calicut, not otherwise recorded at Cochin or Mangalore. On the east coast the incursion of young oil sardine (45-110mm) into the inshore ground was reflected only in the boat seine catches at Visakhapatnam and (70-110mm) in the *Edavala* at Madras.



Oil sardine catch by ring seine at Cochin (length range 85-135 mm)

Thus, considering the composition of the oil sardine catches at different centres, it can be stated that the fishery during the year depended on 0- and 1-year old fish in the inshore waters.

Compared to last year the higher occurrence of advanced maturity stages in oil sardine indicated good spawning activity during April/May onwards along the west coast and at Visakhapatnam. The new recruits formed 86 % at Mangalore during the post-monsoon period. At Calicut the new recruits of 85 mm and above appeared in the inshore areas during August compared to 60 mm new recruits observed in July last year. In all probability the eggs and the larvae are carried as far south to the equator by the equatorial current developed by the fag end of the pre-monsoon period. While part of this may be carried to the east coast the majority of the juveniles are again brought to the inshore areas on the south west coast by the clock-wise current during the southwest monsoon. Young juveniles of 40-50 mm have been found to occur along with young mackerel in the ring seine landings at Ambalapuzha

and further southern regions by the middle of June. There may be yearly variation in the intensity of the current and its tongues that reach the inshore belt, because during last year young sardines were observed along the Cochin areas, but this year they were noticed at Alleppey, Calicut and along the northern areas. The spawning time of oil sardine on the east coast also appeared to be similar and synchronized. Young sardines of 45mm and above are exploited by the boatseines by June at Visakhapatnam. The higher abundance of spawning population during this year indicated good recruitment compared to the previous year and in all probability a good fishery of oil sardine could be expected in 1998. A correlation between oil sardine landings and Sun spot activity also indicated a promising trend.

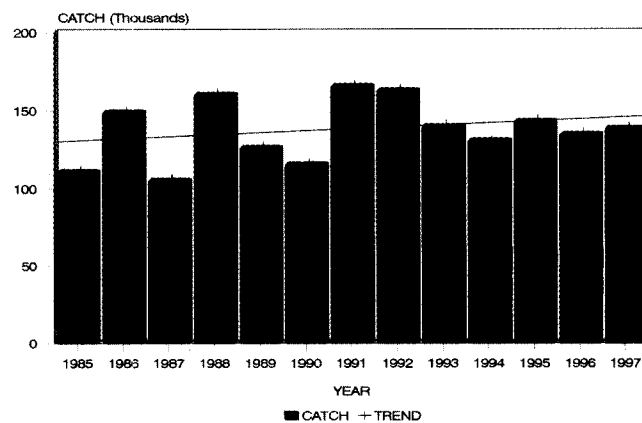
Large quantities of oil sardine were brought to the markets in Kerala from Karnataka and Tamil Nadu and sold at Rs.20/ kg. As the local purse seine fishermen were not realizing better remuneration they have been diversifying the effort input to bottom trawling especially during the post monsoon season.

FISHERY AND RESOURCE CHARACTERISTICS OF ANCHOVIES (PF/RE/1.2)

R. Thiagarajan, M. Zaffar Khan, Prathibha Rohit, P.N.Radhakrishnan Nair,
A.A. Jayaprakash and K. Dorairaj

During the years 1985 to 1997, the maximum catch of 1.65 lakh t of anchovies was recorded in 1991 and the minimum of 1.05 lakh t in 1987. The present catch of 1.38 lakh t is slightly more than the previous year's catch (1.33 lakh t). This revealed that the catch is almost stabilized between 1 and 1.6 lakh t. Statewise, Kerala accounted for the maximum share (21.9%) in 1997 followed by Gujarat (19.7%) and Tamil Nadu (19.5%).

Investigations on anchovy resources



All India landings (t) of anchovies (1985-1997)

were carried out at four centres on the west coast (Bombay, Mangalore, Cochin and Vizhinjam) and two centres on the east coast (Mandapam and Madras).

The anchovies were exploited all along the coast by a variety of gears like purseseines, trawls, ringseines, do/nets and shoreseines. At Mangalore, the resource was mainly exploited by the purseseines and trawls. The resource formed 2,449 t at a C/E of 225 kg and 1,637 t at a C/E of 5 kg in the above gears respectively. The catch improved by 1.5 fold in the purseseines and 2.6 fold in the trawls. The ringseine fishery at this centre was a failure. At Malpe, the anchovies were poorly represented in the purseseines compared to 92 t landed last year. The trawls with a landing of 628 t indicated a four fold increase. The ringseine catch was a mere 242 kg against 5 t in last year. At Cochin, no catch was recorded in the purseseines compared to 45 t in trawls and 54 t in ringseines. The catch increased by 13% in trawls but decreased by 17 fold in ringseines. The C/E in ringseine was 22 kg compared to 435 kg during the last year. At Mandapam, the trawls exploited 87 t at a C/E of 1.4 kg, but the shoreseines dragged only 2.7 t at a C/E of 13 kg. At Madras the trawls landed 324 t at a C/E of 13.6 kg.

Whitebaits constituted nearly 25% in the shoreseines at Mandapam; 18% in purseseines and 5% in trawls at Mangalore; 2% in trawls at Malpe and 14% at Madras. In the ringseines anchovies formed 4% at Cochin. *S. devisi* dominated the anchovy catch at all centres except in the shoreseines at Mandapam and in the ringseines at Cochin. The fish constituted 92% in the trawls at Mangalore and 74% at Malpe. The next dominant species at this centre was *S. bataviensis*. In the purse seines 99.7% of the anchovy catch was formed by *S. devisi* at Mangalore. At Cochin and Madras, in the trawls, *S. devisi* contributed to 53%. *S. macrops* was the dominant species (75%) followed by *S. devisi* and *S. bataviensis* in the ringseines at Cochin. At Mandapam, *S. commerson* (88%) followed by *S. indicus*

constituted the boatseine catch. The production of golden anchovy *Coilia dussumieri* was 33513 t along the northwest coast which indicated 8% increase over last year.

The most common species *S. devisi* was in the size range of 70-95 mm in almost all the gears at these centres. The same trend in size groups (75-105 mm) was observed in *S. bataviensis* also. *S. macrops* were in 60-75 mm at Mangalore/Malpe. But at Cochin, in the ringseines the 50-100 mm size groups were seen. *S. buccaneri* was not observed at Cochin, but at Malpe this fish of 65-80 mm range was recorded. *S. indicus* of 110-140 mm in trawls and 65-95 mm in ringseines at Cochin were observed. At Mandapam *S. commerson* of 45-125 mm constituted the trawl catch.

Females dominated the *S. devisi* population exploited by the trawls at Mangalore/Malpe compared to males in the purseseine catch. Males dominated *S. macrops* exploited by trawls at Malpe and by the ringseines at Cochin. In *S. buccaneri*, males dominated in trawls at Malpe and Cochin. Sexes were equally represented in *S. commerson* at Cochin compared to males at Mandapam area. Males dominated in *S. indicus* at Cochin and females at Mandapam area.

The representation of spawning population of *S. devisi* was 63% in trawls, 6% in purseseines at Mangalore; 25% in trawls at Malpe; 7.5% in trawls and 53% in ringseines at Cochin. Spawning population of *S. macrops* ranged from 40% in trawls at Mangalore, 6% in trawls at Malpe; and 27% in ringseines at Cochin. In the ringseine catch at Cochin mature *S. commerson* formed 39% compared to 3% at Mandapam.

The delay in the S.W. monsoon by about two weeks appeared to have delayed the entry of *S. macrops* to the fishing areas of ringseines at Cochin. Though there was an increase in effort of ringseines by 14%, the catch

declined drastically compared to the previous year. The concentration of *S. buccaneri* (*Karinatholi*) on the southern coastal areas of Thottappally spillway also was poor. This species appeared to tolerate low saline waters generally concentrate at southern Alleppey coastal belts for feeding on microorganisms within the

area and also on those brought along with the fresh-water influx from the spillway during the S.W. monsoon. The delayed monsoon had a lag effect on the influx of fresh water to the sea resulting in the diversion of fish shoals, *S. buccaneri* at Alleppey area and *S. macrops* at Cochin resulting in the decreased landings.

FISHERY AND RESOURCE CHARACTERISTICS OF SEERFISHES (PF/RE/2.1)

C.Muthiah, B.Manoj Kumar, T.M.Yohannan, N.G.K.Pillai and H.Mohammed Kasim

The seerfish catch during 1985 to 1997 ranged from 0.28 lakh t in 1990 to 0.46 lakh t in 1995. In 1997 the catch was 37,537 t. The annual average catch was around 0.4 lakh t. State-wise, Gujarat recorded the maximum share (29%) in 1997 followed by Tamil Nadu (18%), Andhra Pradesh (11.5%), Maharashtra (10.1%), Karnataka (6%), Orissa (3.7%), Andaman (1.7%), West Bengal (1.6%) and the rest by other states.

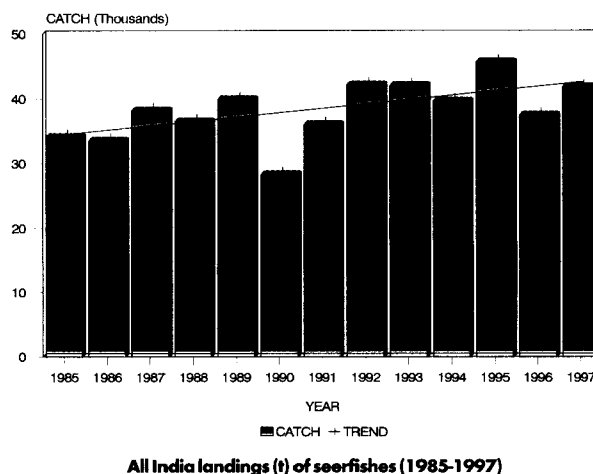
Studies on the fishery and resource characteristics of seerfishes were carried out at seven centres, four on the west coast (Veraval, Mangalore, Calicut and Cochin) and three on the east coast (Tuticorin, Madras and Visakhapatnam).

The landings of seerfish showed a marginal decline (10.6%) as compared to 1996. The catch from all the seven centres collectively was 3,784 t. A decrease in production ranging from 10.2% (Tuticorin) to 49.9% (Cochin) was recorded at all centres except the northern most centre, Veraval where the catch increased by 15.5%. The landing was highest at Veraval (1,771 t) and lowest at Calicut (119 t) in the west coast. Along the east coast Tuticorin recorded the highest catch of 549 t and Visakhapatnam the lowest of 137 t. The enhanced production at Veraval was due to better abundance of the resource as well as increased

effort input, by both the gillnets and bottom trawls. The decrease at other centres was due to the reduced effort and less abundance in both gillnet and trawl fishing grounds off Mangalore-Malpe and Cochin, poor availability in the gillnet fishing grounds off Calicut, and Tuticorin, Madras and Visakhapatnam.

The peak fishing season was January at Madras, January-March at Veraval, May-September at Tuticorin, September-November at Cochin and Mangalore, August-September at Calicut and October-November at Visakhapatnam.

Drift gillnet was the major gear contributing 56.1% to the total seerfish catch from all centres, followed by bottom trawl (31.9%), hooks & lines (9.9%), purse seine (1.5%) and indigenous gears (0.6%).



Drift gillnet was the chief contributor along the west coast (Veraval 66.1%, Mangalore 48.1%, Calicut 82.5% and Cochin 97.1%). The total gillnet effort varied from 2,591 units (Madras) to 32,204 units (Veraval), the catch from 59 t (Visakhapatnam) to 1,171 t (Veraval) and the C/E from 4.3 kg (Visakhapatnam) to 48.0 kg (Madras).

Trawl was the major gear for seerfish exploitation at Tuticorin (49.8%). In other centres the seerfish catch by trawl varied from 51 t (Madras) to 600 t (Veraval) with C/E ranging from 0.2 kg (Cochin) to 10.0 kg (Mangalore-Malpe).

Hooks & lines was the major contributor at Madras (51.9%) and Visakhapatnam (57.3%). The catch and C/E were highest at Madras (189 t; 46.4 kg) and lowest at Visakhapatnam (79 t; 3.3 kg).

Purse seine landed 56.6 t (C/E = 3.1 kg) at Mangalore-Malpe and 1.2 t (C/E = 0.4 kg) at Cochin.

Indigenous gears landed 0.75 t at Mangalore-Malpe during the monsoon season (July-August) and 20.8 t at Calicut during January and March-May periods.

Among the four species in the fishery, the king seer *Scomberomorus commerson*, the spotted seer *S. guttatus*, the streaked seer *S. lineolatus* and the wahoo *Acanthocheilichthys solandri*, the first two species were important contributing 59.9% and 39.4% respectively to the total seerfish catch from all centres. The king seer was the only species at Cochin and was dominant at all centres except at the northernmost centres, Veraval and Visakhapatnam where *S. guttatus* was the major species. Gearwise also, the above trend was observed.

The size range of *S. commerson* was 22-134 cm in the large mesh drift gillnet, 14-72 cm in the small sized mesh gillnet *podivalai* at Tuticorin, 12-108 cm in bottom trawl, 48-128 cm in hooks & lines and the fishery was mainly supported by 34-112 cm, 14-58 cm, 12-100 cm and 48-128 cm size groups respectively. Youngfish (18-34 cm) component in the fishery was negligible in the big sized mesh gillnet but they were exploited heavily by *podivalai* (74.7%) at Tuticorin, trawl at Tuticorin (66.5%), Mangalore (42.9%) and Cochin (29.3%) as observed in the previous years.

The length of *S. guttatus* ranged from 20 to 68 cm in gillnet and 18-58 cm in trawl. The fishery by both gears was supported chiefly by 20-64 cm size groups.

FISHERY AND RESOURCE CHARACTERISTICS OF TUNAS, TUNA LIVE-BAITS AND BILLFISHES (PF/RE/2.2)

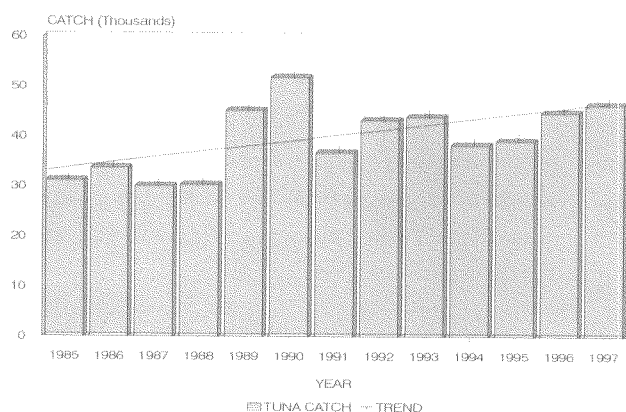
P.P. Pillai, B. Manoj Kumar, M. Zaffar Khan, C. Muthiah, T.M. Yohannan, N.G.K. Pillai, R. Thiagarajan, H. Mohammed Kasim, M. Sivadas and A.K.V. Nasser

The tuna production during 1985 to 1997 ranged from 0.3 lakh t in 1985 to 0.52 lakh t in 1990. The present production of 46,390 t in 1997 is the second highest recorded during the last thirteen years. Kerala was the major contributor (34.5%) in 1997 followed by Gujarat (20.1%), Lakshadweep (14.4%) and Tamil Nadu (10.5%).

Studies on the fishery and resource characteristics of tunas, tuna live-baits and billfishes were continued at

Veraval, Bombay, Mangalore, Calicut, Cochin, Vizhinjam, Tuticorin, Madras, Minicoy and Agatti.

During 1997, tuna production increased at Bombay (109.9%), Mangalore (75.9%), Calicut (463.2%), Cochin (59.9%), Tuticorin (1.0%) and Madras (223.6%) when compared to the previous year. The fishing effort increased at most of the centres (5.8% to 261.5%), the C/E declined at major centres like Veraval, Bombay, Minicoy and Agatti.



All India landings (t) of tunas (1985-1997)

Though there was a significant increase in the catch at Calicut, Madras, Bombay, Mangalore, Cochin and Tuticorin, other centres recorded a notable decrease. The catch and percentage of increase/decrease when compared to the previous year were as follows: Veraval 1777.8 t (-39.5%), Bombay 275.9 t (+109.9%), Mangalore 377.5 t (+75.9%), Calicut 77.4 t (+463.2%), Cochin 1379.9 t (+59.9%), Vizhinjam 2696 t (-33.7%), Tuticorin (+1.0%), Madras 224.2 t (+223.6%), Minicoy 689.3 t (-27.1%) and Agatti 1160.4 t (-4.6%). The catch per effort in gillnet varied from 17.3 kg at Calicut to 172.2 kg at Cochin. In pole and line it was 261.9 kg at Minicoy and 298.5 kg at Agatti.

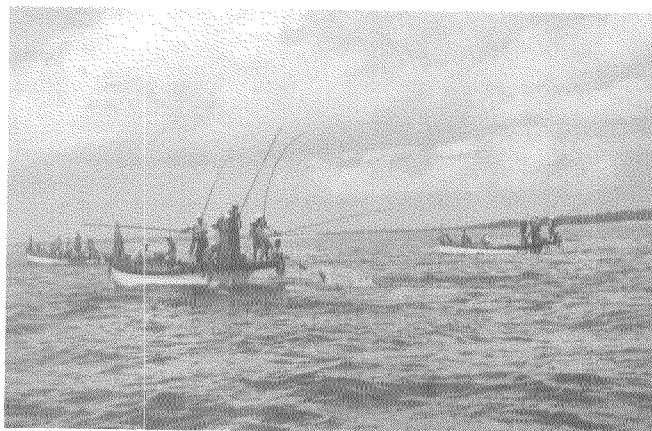
In the monsoon fishery at Minicoy, the total fish catch was 1.6 t with a CPUE of 31 kg. Hooks and lines was the major gear accounting for 91% of the total catch.

Among tunas, *Euthynnus affinis* constituted the major species (35.9%) at all the centres along the mainland except at Vizhinjam where *A. rochei* constituted 58.3% of the total tuna catch. *K. pelamis* contributed 18.3%, *Thunnus tonggol* (9.4%), *Auxis thazard* (9.0%), Yellowfin (*Thunnus albacares*) (8.6%), *Auxis rochei*

(7.7%) and *Sarda orientalis* (3.0%) of the overall tuna catch.

Istiophorus platypterus (5.7%), *Makaira indica* (1.9%) and *Xiphias gladius* (0.5%) contributed the billfish catch at different centres along the mainland. At Minicoy, in the pole and line fishery *K. pelamis* constituted 89.1% and *T. albacares* 10.9%. In the hand lines operated at Minicoy, *T. albacares* constituted 91.7%. At Agatti *K. pelamis* constituted 97.6% of the total tunas caught followed by *A. thazard* (1.8%), *T. albacares* (0.4%) and *E. affinis* (0.2%). In 1997 the species composition did not evince much variation from that of 1996.

The size range of *E. affinis* in the fishery was 24-68 cm, with fishery supporting group in the 38-64 cm size range; that of *A. thazard* 22-54 cm with modes in the 34-42 cm size groups; that of *K. pelamis* 24-68 cm with modes in the 42-64 cm size groups; that of *T. albacares* 28-90 cm with modes at 42-86 cm size group; that of *S. orientalis* 36-54 cm with modes at 43-48 cm size group and that of *A. rochei* 22-34 cm with modes in the 24-28 cm size group.



Pole and line fishing at Minicoy

Bait-fish fishery at Minicoy and Agatti

The bait-fish catch at Minicoy was 9.7 t with a CPUE of 3.9 kg. At Agatti, the baitfish catch was 56.3 t with a CPUE of 14.5 kg when compared to the previous year the effort increased by 21.8% at Minicoy and 11.5% at Agatti. Similarly the catch increased by 40.4% and 12.1% at these centres respectively.



Tuna livebait collection for transport

Induced breeding of live-baits

During April, *Pristiapogon snideri* of size 50-115 mm were collected from the lagoon and kept alive in the aquarium. One batch of 10 numbers were given HCG at a dose of 25 once in a day for two consecutive days. Another batch was given a dose of 0.1 ml of ovaprim. The fishes injected with HCG showed some developments like slight bulging out of the eye, intake of food etc. The other fishes treated with ovaprim did not show any visible change either in their behaviour or in their appearance. The examination of dead fishes indicates that all were in immature condition.

Biology

At Minicoy, biology of *K. pelamis* had been studied. The feeding condition showed the dominance of baitfishes in different months. The natural food items

were squids and prawns. Caesionids were the dominant baits observed. The food items were seen in partially digested condition.

The maturity condition showed the presence of both mature and immature fishes. The adult ones ranged from stage IV to VII a. Partially spent ones dominated among the mature fishes.

With regard to *T. albacares* all were juveniles and their stomachs were empty.

Stock Assessment

At Bombay, Mangalore and Tuticorin centres, stock assessment work has been done. At Bombay, the growth parameters estimated for *E. affinis* are $L_{\infty} = 83.0$ cm and $K = 0.72$. The total mortality coefficient (Z) was estimated at 3.84 with $F/Z = 0.79$. The present level of fishing is close to the optimum.

At Mangalore, *E. affinis* fishery was supported by 1-3 year old groups in purse seine and 1-2 year old groups in gillnet. In the case of *T. tonggol*, the fishery was sustained by 0-1 year old groups and for *A. thazard* it was supported by 1-year old fishes. Based on the growth parameters estimated earlier, the mortality rate (Z), the exploitation ratio E , the exploitation rate U , the total stock Y/U , the standing stock (Y/F), the mean length in the fully recruited group L and the length at first capture L_c in respect of the dominant tuna species exploited by gillnet have been estimated. From the exploitation ratio it is seen that all the three species were underexploited.

At Tuticorin, L_{∞} , K and t_0 of *E. affinis* are estimated to be 81.0 cm, 0.8/yr and 0.0058 yr and of *A. thazard* to be 61.7 cm, 1.09/yr and 0.0017/yr respectively. The mortality is estimated to be 1.32 for *E. affinis* and 1.69 for *A. thazard*. The Z and F are estimated to be 4.7 and 3.38 for *E. affinis* and 4.08 and 2.39 for *A. thazard*.

respectively in *Paruvalai* (gillnet). The exploitation rate (U) is estimated to be 0.71 and 0.58 for *E. affinis* and *A. thazard* respectively in *Paruvalai*. The stock of

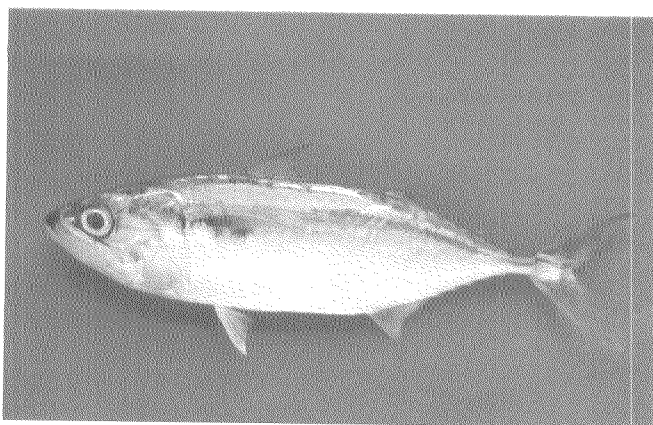
E. affinis is estimated to be 207.8 t and of *A. thazard* 110.9 t in the fishing grounds of *Paruvalai*.

FISHERY AND RESOURCE CHARACTERISTICS OF MACKEREL (PF/RE/2.3)

T. M. Yohannan, U. Ganga, Prathibha Rohit, P.P. Pillai, P.N. Radhakrishnan Nair,
R. Thiagarajan, H. Mohammed Kasim and E.M. Abdussamad

There were wide annual fluctuations in mackerel landings as the minimum catch was 0.6 lakh t in 1985

and the maximum 2.9 lakh t in 1989. The present production of 2.24 lakh t is less than the previous years' production. areas when compared to the last year. But, in Mangalore, Cochin, Tuticorin and Mandapam there was a decline in landings. Along the west coast the catches were good in August/September whereas, along the east coast the catches were better in April/May except in Madras where peak catches were made in July. Size groups below 170 mm dominated the catches along the west coast. Larger size groups between 200-250 mm contributed to the bulk of the catch along the east coast except in Kakinada and Visakhapatnam where juvenile fishes were caught abundantly. The west coast fishery was dominated by purseseines/ringseines. The most effective gears along the east coast were trawl nets and gillnets. The centrewise details are given below:

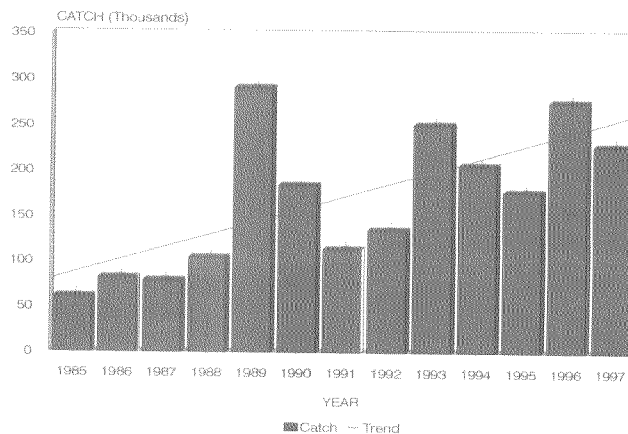


Rastrelliger kanagurta

and the maximum 2.9 lakh t in 1989. The present production of 2.24 lakh t is less than the previous years' production.

The fishery and resource characteristics of mackerel exploited by different gears were monitored at Karwar, Mangalore, Calicut and Cochin along the west coast and at Tuticorin, Mandapam, Kakinada and Visakhapatnam along the east coast.

During 1997 the mackerel fishery showed an improvement in Karwar, Calicut, Visakhapatnam and Kakinada



All India landings (t) of mackerel (1985-1997)

The fishing season at Karwar was from August to December with peak catch in October. In August mackerel of size around 240 mm dominated the catch which declined at a rate of 6.346 (Z). By September the new recruits entered the fishery at a size around 140 mm. The new recruits and the larger size groups already present in the fishery contributed to the peak catch in October. The new recruits were the products of spawning in June/July.

Larger size groups (around 230 mm) dominated the fishery at Mangalore in April/May. A weak recruitment was observed during this period with fishes of size around 150 mm also were being caught. But, the peak recruitment was in September/October when fishes of size around 170 mm dominated the catch. They were the products of spawning in June/July. Their mortality rate was much lower (3.754).

There was a clear peak in catch in September at Calicut when new recruits of size around 150 mm dominated the catch. As in Karwar and Mangalore larger size groups of length around 230 mm, which clearly were the previous year's recruits, dominated the fishery till March. By April products of a subsequent weak recruitment also appeared in the fishery. The products of peak recruitment in September, born in June/July declined at a total mortality rate of 6.076.

At Cochin, the situation was almost similar as that of Calicut. peak catches came in September when dominant size group was around 140 mm, smaller than what observed in Calicut. The previous year's recruits and the products of subsequent weak recruitment dominated the fishery till June. The products of peak recruitment in September, born in June/July declined at a total mortality rate of 5.904.

Along the west coast there was a clear pattern of recruitment to the mackerel fishery. The peak spawning during this year occurred during June/July. This has to be considered as a delay of one month. Normally peak

spawning used to take place in May/June. The probable reason can be the delay in the onset of monsoon which might have caused a delay in peak upwelling and plankton bloom. However, the products of this spawning dominated the fishery subsequently along the west coast. Their growth was found to be very fast with an L_{∞} value of 270 mm and a K value of 2.8. A very strong amplitude in the growth rate was observed with a decline in growth rate during the period from November/December to February/March.

The exploitation of the new recruits started early in September at Cochin and spread to northern centres subsequently. In Karwar it commenced early in October. Their exploitation rate was low in Mangalore (0.201), more at Cochin (0.492) and the highest at Calicut (0.506). The size at peak exploitation was 140 mm at Cochin, 150 mm at Calicut and 170 mm at Mangalore. In Karwar the peak exploitation was from the products of the previous year's recruitment at a size of 230 mm with a high exploitation rate of 0.527.

Along the west coast where large purseseines and ringseines with very small mesh exploit the juveniles abundantly, the peak exploitation is on 2 or 3 month old mackerel. In spite of the high K and M values, the commencement of exploitation considered as too early in Cochin and Calicut. The high exploitation rate of previous year's recruits observed in Karwar is of no serious consequence as the average size of capture is nearer to L_m . Another important observation is the steep rise in the mackerel catch by trawlers at Cochin, Calicut, Mangalore and Kakinada.

At Tuticorin the peak catches are made in summer by gillnets from previous year's recruits. By the year end the catches by trawl increase and the exploitation is mostly on new recruits. The spawning seems to be during June-August period with peak recruitment in October. Larger size groups dominated the fishery and the decline started from around 200 mm from where the

mortality was very high with an exploitation rate of 0.695.

The peak catches are in summer at Mandapam and the bulk of the catch is from fishes of the size above 200 mm.

The peak catches are made in July by trawl and *Edavalai* at Madras. Sizes above 150 mm are generally caught with size groups around 180 mm dominating.

The size groups below 150 mm dominated the catch at Visakhapatnam. Recruitment to the fishery started

in April from the products of spawning in February/March. Strangely fishes of size around 130 mm continued to dominate the fishery from June to September. It is not clear whether this is due to continuous recruitment or and amplitude in growth rate.

The fishery improved steadily from August to December at Kakinada. The new recruits entered the fishery in October. Products of an early weak recruitment sustained the fishery during May to July.

The east coast mackerel fishery is dominated by trawl and gillnets. The exploitation is mainly on larger size groups than observed along the west coast.

FISHERY AND RESOURCE CHARACTERISTICS OF BOMBAYDUCK (PF/RE/3)

Alexander Kurian and B. Manoj Kumar

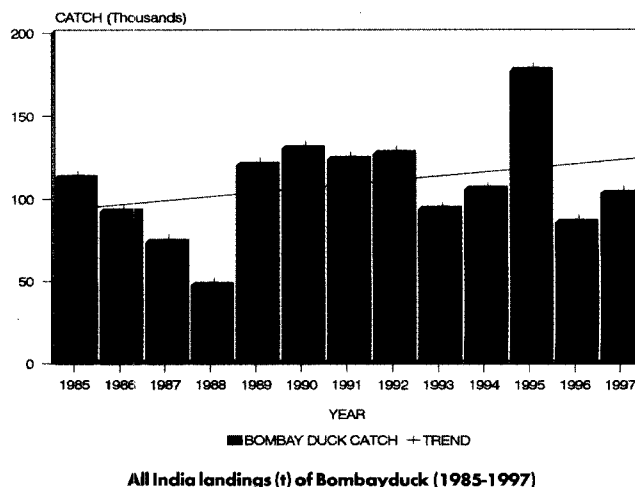
There was annual fluctuations in Bombayduck (*Harpodon nehereus*) landing as the minimum catch was 0.47 lakh t in 1988 and the maximum 1.77 lakh t in 1995. In 1997 the catch was 1.03 lakh t. About 77.7% was landed in Gujarat followed by Maharashtra (16.3%), West Bengal (5%), Andhra Pradesh (1%) and Orissa (0.5%).

Investigations on the fishery and resource characteristics of Bombayduck were carried out at Sasoon dock, Bombay and Jaffrabad, Rajpara and Nawabunder along the Sourashtra coast.

Bombayduck (*Harpodon nehereus*) fishery of India during 1997 showed an increase of 12.5% in total production compared to the previous year. On the positive side, even with the reduction of 33% in effort, a catch rate of 84.25 kg per haul was obtained. The total Bombayduck catch for the region was estimated at 65,194 t against an effort of 77,3827

hauls by *dohets*. The total production for the region in 1996 was 72,610 t against an effort of 11,565 23 hauls at a catch rate of 63 kg per haul.

Encouraged by the catch rate of 310 kg per haul during 1996 (306 kg in 1995-96), Maharashtra increased the effort by 67% to 54774 hauls during 1997 resulting in a production of 3020 t at the catch rate of 55.14 kg thereby indicating 70% reduction in



the landings. On the contrary, Gujarat reduced the effort by 36% to 719053 hauls resulting in a production of 62,174 t with a catch rate of 86.47 kg per haul. The drop in total production was negligible but increase in catch rate from 56 kg in 1996 to 86 kg in 1997 was considerable. The Bombayduck formed 57% of the total *do*/landings in Gujarat and 68% in Maharashtra followed by *Acetes* sp. and golden anchovy.

Studies on food habits indicate that juvenile Bombay duck constituted an important food item (cannibalism). It also foraged on co-habiting organisms like non penaeid prawns and golden anchovies.

Observation on reproduction showed that mean lengths at first, second, third and fourth spawning were at 252 mm, 306 mm, 347 mm and 373 mm, and fecundity increased with increase in total length but reduction of ova size was observed. The presence of immature, maturing, gravid and spent individuals throughout the year indicated that Bombay duck is a continuous breeder.

With the minor variations in the largest size groups, Bombayduck of the size range 30-314 mm were exploited along the Maharashtra and the Gujarat coasts. But the commercial fishery was supported by 190-260

mm sized fishes. At Veraval nearly 40 % of the catch was constituted by juveniles compared to 20% recorded in Maharashtra. The occurrence of advanced maturity stages almost through out the year indicated the concentration of spawning population in Maharashtra region rather than in Gujarat area. The new recruits, maturing and spent fishes turn shoreward and migrate towards north and are vulnerable to the *do*/nets in Gujarat side and to some extent along the Maharashtra coast. The juveniles caught along Gujarat area amounted to more than 40%. The pre-adults, as they mature start migrating southward mostly through offshore areas taking advantage of the prevailing current system characteristic to the extensive continental shelf in the north-west region. This appeared to be a cyclic process and the success of the fishery depended on the intensity of spawning, recruitment and survival of the new recruits.

Analysis of catch and effort data from 1949 to 1995 suggested a 10-year cycle as the fishery has a tendency to find it's own equilibrium under changing exploitation rate. However it is still not known how far the fishery can attain a balance with drastic natural and anthropogenic changes in the habitat.

FISHERY AND RESOURCE CHARACTERISTICS OF RIBBONFISHES (PF/RE/4)

P.N.Radhakrishnan Nair, B.Manoj Kumar, M. Zaffar Khan, U.Ganga, C.Muthiah, and R.Thiagarajan.

During the years 1985 to 1997, the ribbonfish production was maximum (1.7 lakh t) in 1997 and minimum (0.65 lakh t) in 1990. The current yield of 1.7 lakh t recorded in 1997 is the highest during the last 13 years. This was mainly due to the target fishing on this resource which has gained an export market in the northeast Asian countries, especially in China. Gujarat contributed the maximum share (46.1%) followed by Maharashtra (25.9%), Kerala (11.2%) and the rest by other states.

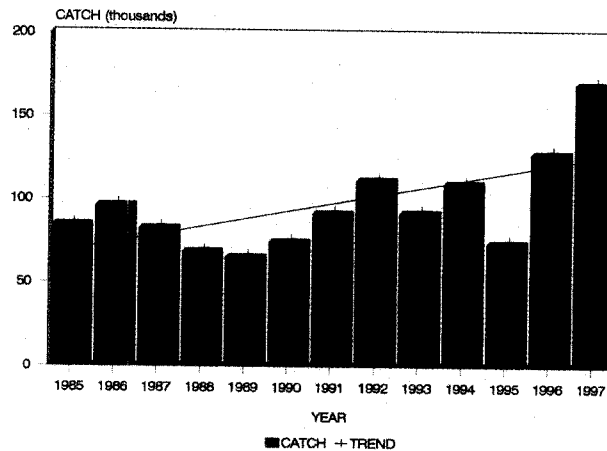
The major gear exploiting the ribbonfish resources in India is the trawl net. Nearly 99.3% of the annual catch was landed by this gear. During 1997 ribbonfish constituted from 0.01% (Visakhapatnam) to 16.3% (Veraval) of the total trawl landings at Veraval, Mumbai, Karwar, Mangalore, Cochin, Madras, Kakinada and Visakhapatnam. It was also caught in gillnet, purseseine, boatseine and other indigenous gears in certain centres like Veraval, Madhwad, Mangalore, Cochin, Vizhinjam, Madras and Visakhapatnam. At

Viahinjam only traditional gears were operated and ribbonfish were caught in boatseine and drift gillnet.

During 1997, an increase in the effort of trawl unit was noticed at Veraval (6.5%), Mumbai (14.4%), Mangalore (2.3%) and Cochin (7.7%), compared to 1996. In other centres such as Karwar, Madras, Kakinada and Visakhapatnam the number of effort decreased by 7.1% (Madras) to 32% (Karwar). In the case of gillnet both at Veraval & Madhwad the effort as well as catch decreased but at Cochin the catch decreased by 17.8% and the effort increased by 9%.

The estimated ribbonfish landing in trawl ranged from 120.3t at Karwar to 16247.6t at Veraval along the west coast and from 64t at Visakhapatnam to 3190t at Kakinada along the east coast. In other centres the landings were 5981t at Mumbai, 6771t at Mangalore 1647t at Cochin and 1031t at Madras. The estimated landings in gillnet at Veraval, Madhwad and Cochin were 56t, 69t and 6.5t respectively. Tremendous improvement in the ribbonfish catch was noticed in boatseine at Visakhapatnam. It landed 98t of ribbonfish which was 84t more than that of 1996. A total improvement in the ribbonfish fishery could be noticed only at Veraval and Mangalore where the effort, catch and catch rate increased where as at Kakinada though the catch increased the effort declined. As a result the catch rate showed an increase of 47% than in 1996.

The C/E in trawl ranged from 8.9kg at Karwar to 188kg at Veraval with 187.5kg at Mumbai, 98.7kg at Mangalore and 58kg at Cochin along the west coast. In the east coast it ranged from 0.6kg at Visakhapatnam to 75.8kg at Kakinada with 42kg at Madras. The catch rates in gillnet were 2kg at Veraval, 3.2kg at Madhwad and 0.9kg at Cochin. It was 63kg in boatseine at Visakhapatnam.



All India landings (t) of ribbon fish (1985-1997)

Along the west coast the fishery existed almost throughout the year at Veraval, Mumbai, Karwar and Kochi, except for the period of June-July when the trawling was suspended due to monsoon. The peak periods were April-May (29%) and September to December (55%) at Veraval; January-May (50.8%) and September-December (48.5%) at Mumbai; January-February (67.6%) and November (9.4%) at Karwar; April-May (46.4%) and October (33.3%) at Mangalore; August-October (91.4%) at Cochin; January-February (56%) and November-December (30.8%) at Madras; May (4.7%) and September-December (88.9%) at Kakinada; and August-September (48.4%) at Visakhapatnam. It could be noticed that the post monsoon period of September to December was generally the peak period of ribbonfish landings.

Trichiurus lepturus was the dominant species in all the centres. From Kakinada and Visakhapatnam other species like *T. russelli*, *Lepturacanthus savala*, *L. gangeticus*, *Eupleurogrammus muticus* and *E. glossodon* were also reported and they together constituted 10% and 5% respectively.

The minimum size of recruitment of *T. lepturus* in trawl was 19cm reported from Visakhapatnam in the month of July. In other centres it was 20cm at Veraval

(April, May & September), 30cm at Mumbai (March), 22cm at Mangalore (September), 24cm at Cochin (August), 25cm at Madras (January, October & December) and 22cm at Kakinada (August). The recruitment size in gillnet was 40cm both at Veraval (June) and Madhwad (May). The smallest size caught in boatseine was 16cm at Visakhapatnam in July-August.

The largest size of *T.lepturus* caught in trawl net was 114.9cm noticed at Mumbai. In gillnet and boatseine the length ranged upto 112.9cm (Veraval) and 69.9cm (Visakhapatnam) respectively. The major modes observed in trawl net were at 62cm at Veraval, 55cm at Mumbai, 64cm at Mangalore, 74cm at Cochin, 35cm at Madras, 58cm at Kakinada and 46cm at Visakhapatnam.

The exploitation of fish measuring less than 50cm was maximum at Visakhapatnam (79.8%) followed by Madras (68.5%) and it was minimum at Cochin (2.4%).

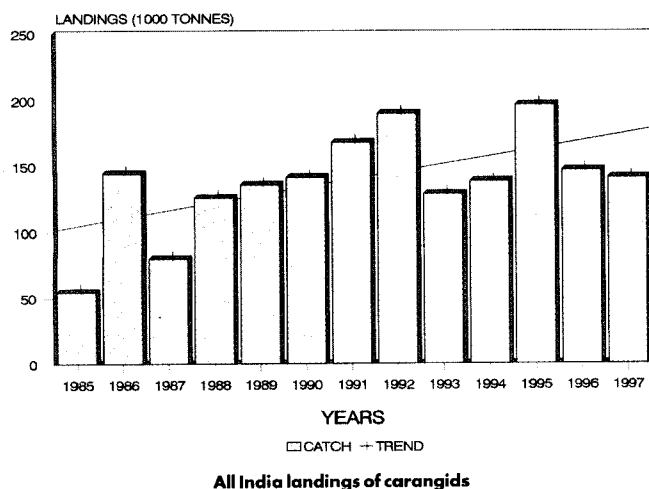
50-100cm size groups dominated at Veraval (62.7%), Mumbai (79.4%), Mangalore (85.8%), Cochin (97.2%) and Kakinada (67.4%). Fishes measuring above one metre were maximum at Veraval (4.4%); minimum at Madras (0.1%) and was not represented at Kakinada and Visakhapatnam. In gillnet at Veraval and Madhwad, 50-100cm sized fish dominated forming 62.7% and 76.9% and fishes larger than one metre formed 20.6% and 11.2% respectively. In boatseine at Visakhapatnam 89.2% was contributed by fish measuring less than 50cm.

The sex-ratio (M:F) among the pre-adults, reported from trawl catch at Mangalore, Cochin, Madras, Kakinada and Visakhapatnam were 1:0.9, 1:2.6, 1:0.4, 1:1.5 & 1:0.7 respectively. Among the adults females dominated at Veraval (64.9%), Mumbai (58.3%) and Kakinada (53.9%) and male in other centres. Spawning season was generally from January to June and November.

FISHERY AND RESOURCE CHARACTERISTICS OF CARANGIDS (PF/RE/5)

H.Mohammed Kasim, B.Manoj Kumar, Prathibha Rohit,
P.N.Radhakrishnan Nair and R. Thiagarajan

The catch of carangids during 1985 to 1997 ranged from 0.5 lakh t in 1985 to 1.97 lakh t in 1995.



The production during 1997 was 1.38 lakh t. Kerala contributed 35.5% of the total carangids catch followed by Tamil Nadu (19.3%), Karnataka (11.9%) and the rest from the other states.

Investigations were carried out at Veraval, Mangalore, Cochin and Vizhinjam on the west coast and Tuticorin on the east coast.

The annual production of carangids recorded around 50,000 tonnes till 1985 crossed 1,30,000 tonnes by 1986 and reached 1,80,000 tonnes in 1992 all the while depicting characteristic fluctuations. Realising the importance of this resource,

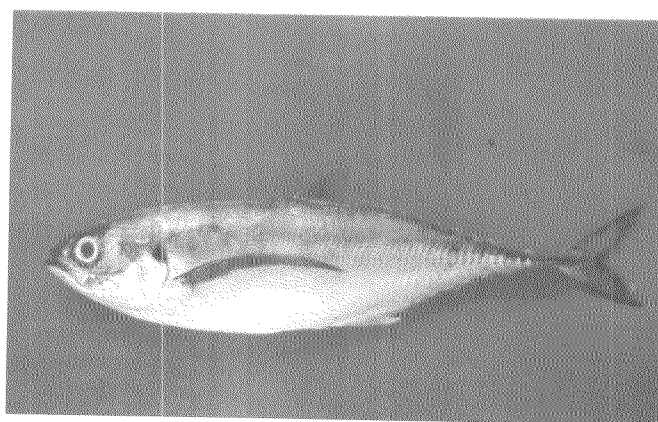
a project on the fishery and resource characteristics of carangids was initiated in April 1997.

The studies indicated good concentration of the resource off Tuticorin followed by Mangalore/Malpe, Veraval, Cochin and Vizhinjam in that order of importance. The resource, especially the smaller ones were exploited by purseseines, ringseines and trawls compared to larger varieties by the gillnets and hooks and lines. At all the centres except Vizhinjam the trawl appeared to be the dominant gear. The catch by various gears indicated that larger ones are available in the deeper areas compared to smaller ones in the inshore grounds.

At Veraval, 836 t at a C/E of 13 kg was landed by the trawls compared to 283 t at a C/E of 13 kg by the gillnets. At Mangalore, the trawls, purseseines and gillnets contributed 2,286 t, 1,337 t and 12 t respectively. The highest C/E of 146 kg was in the purseseines compared to 83 kg in the trawls and 5 kg in the gillnets. At Mangalore/Malpe, the trawls (2,106 t), Purseseines (609 t) and gillnets (914 t) exploited the resource at a C/E of 108 kg, 12 kg and 0.4 kg respectively. At Cochin, the trawls landed 663 t compared to 110 t each by the ringseines and gillnets followed by 88 t in the purseseines. But the highest C/E of 71 kg was in the purseseines against 33 kg in the trawls and 30 kg in the ringseines. The hooks and lines at Vizhinjam landed 388 t at a C/E of 13 kg followed by 198 t by drift gillnets and 166 t by the non-mechanised hooks and lines. The boatseines and *Chalavala* landed 146 t (C/E 12 kg) and 23 t (3 kg) at this centre. Compared to all other centres a highest catch of 4,036 t at a C/E of 122 kg was landed by the trawls at Tuticorin. Other gears like *Paruvala* landed 206 t (C/E 48 kg) compared to 18 t by *Podivala*. The hooks and lines exploited 573 t at a C/E of 29 kg.

The carangid resource constituted 1% in the trawls at Veraval; 10.5% in purseseines, 8.7% in trawls and 4.6% in the gillnets at Mangalore; 1% in trawls, 5.3% in purseseines and 0.3% in gillnets at Malpe; 5.5% in trawls, 5.4% in ringseines, 4.8% in gillnets and 4% in purseseines at Cochin; and 24% each in hooks and lines and *Paruvala*, 16% in trawls and 4% in *Podivala* at Tuticorin.

At Veraval, *M. cordyla* (46.3%), *D. russelli* (11.4%), *A. atropus* (8.9%), *Scomberoides* spp. (7.5%) and other carangids constituted the catch. At Mangalore/Malpe the gillnet catch was dominated by *M. cordyla* (39.7%) and *Scomberoides* spp. (6.4%). But in trawls *C. kalla* (47.6%) dominated followed by *Decapterus* spp. (23.7%), *D. russelli* (23%), *S. tala* (17%) and *M. cordyla* (6.5%). As in Mangalore, the purseseine catch at Cochin was dominated by *C. kalla* (34%) followed by *D. russelli* and *Scomberoides* spp. It appears that *Decapterus russelli* was abundant at slightly offshore ground at Cochin, because the species formed nearly 72% in trawls at this centre. The inshore population was exploited by the ringseines which constituted 50% of the total carangids exploited by the gear. Others like *A. djeddaba* (27%) also were noticed. In the gillnets *M. cordyla* (23%) and *A. djeddaba* (12%) were the main constituents. At Vizhinjam, in the drift gillnets, boatseines and hooks



Megalaspis cordyla

and lines *Decapterus* spp. dominated. It was interesting that the *Decapterus* spp. exploited all along the west coast was conspicuous by their absence along the east coast at Tuticorin. Here, *S.leptolepis* (42%) followed by *C.carangus* (18%) dominated the trawl catch compared to the domination of *M.cordyla* (33%), *Scomberoides* spp. (19%) and *C.sexfasciatus* (14%) in *Paruvala*; *C.sexfasciatus* (69%), *C.melampygus* (13%) and *C.malabaricus* (5%) in the hooks and lines; and *C.carangus* (24%) and *M.cordyla* (9%) in the *Podivala*.

Studies on the size groups indicated that the larger fishes in general are distributed offshore. At Veraval *M.cordyla* 26-420 mm were observed in trawls. Unlike the larger specimens of *D.russelli*, the smaller fishes of the size 85-165 mm were exploited by the purseseines, the trawls from still deeper grounds exploited 140-200 mm and the gillnets 140-200 mm at Mangalore. More or less same trend of distribution was seen with respect to *D.macrosoma* and *M.cordyla*. the latter species were in the size range of 95-335 mm in trawls compared to 195-415 mm in the gillnets. Smaller varieties like *C.kalla* were in the size range of 105-125 mm in the purseseines against 95-160 mm in trawls. In the trawls at Cochin *D.russelli* of 100-250 mm; *M.cordyla* 160-340 mm were

noticed. *A.djeddaba* 130-185 mm in the ringseines and 280-360 mm in the gillnets were observed. *C.kalla* mostly 120-155 mm were encountered in the ringseines.

Studies on the maturity stages indicated that in most of the carangid fishes spawning occurred during the pre-monsoon period as well during the fag end of the southwest monsoon. At Veraval, mature specimens of *M.cordyla* were observed during October. At Mangalore/Malpe *D.macrosoma* have been found to enter the inshore areas for spawning. The spawning activity appeared to be intense in *C.kalla* at Mangalore/Malpe and Cochin extending from September to December. For species like *D.russelli* spawning started earlier in the southern areas than in the northern parts. First spawning was observed during May and the second spawning unlike in other species started by August and extended upto October.

Taking into consideration the multispecies resource, the highly seasonal fishery by different pelagic species, the intensity of exploitation of various size groups and the C/E by different gears during seasons, it would be possible to chart out the migratory path of many of the commercial fishes along the west coast based on which fishery forecasts could be attempted.



III. DEMERSAL FISHERIES DIVISION

The demersal finfish account for over one fourth of the marine fish landings of India and the current landings have almost approached the potential yield level. Hence, close monitoring of the exploited stocks is essential to enable updating the knowledge on the changes taking place in the exploitation and the characteristics of exploited stocks, and drawing up of strategies for short and long term management of the resources. The division implemented research projects on major exploited demersal finfish resources represented by about 30 species stocks, of which some are responsible for sustaining the demersal finfish fishery in particular regions and the others, all along the Indian coast. All

relevant data required for understanding the dynamics of the exploited stocks were collected and processed during the year under report also and the details are presented below briefly.

In the context of nonavailability of technology for culture and breeding of marine finfish, the division also implemented a multidisciplinary research project on maintenance in confinement and induced maturation of groupers at different centers, with the objective of developing a technology for growout and hatchery production of seed. Satisfactory progress has been made in the project as revealed by the results presented here.

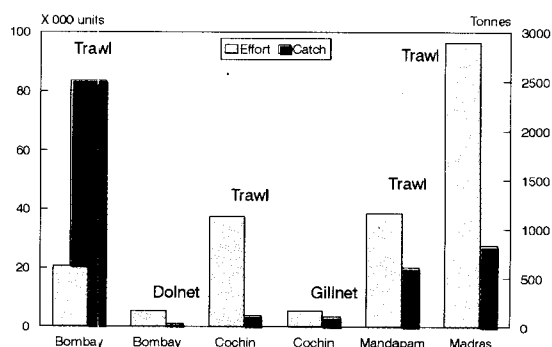
INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF ELASMOBRANCHS (DF/RE/1)

P. Devadoss, S.G.Raje, P.Livingston, K.K.Joshi and Rekha J. Nair

The project work on elasmobranchs was continued from Mumbai, Cochin, Madras, Mandapam and Tuticorin. The trawlers landed elasmobranchs at all these centres; besides, drift gill nets landed these fishes at Cochin, Tuticorin, and Madras; bottom set gill nets at Tuticorin, hooks & line at Cochin and *Dol* net at Mumbai. The estimated catch of elasmobranchs from all these centres was 4600 t, with the trawl contributing 94.4 % of total. Maximum catch was obtained at Mumbai (55.2%) followed by Madras (20.2%), Mandapam (13.2%), Tuticorin (6.1%) and Cochin (5.2%).

The estimated catch of elasmobranchs at Mumbai in the trawl was 2538 t showing an increase of 29 % over that of previous year. The contribution of elasmobranchs to total fish catch was 3.8 % and the catch rate was 79 kg /unit. Sharks

(67 %) were dominant and *Scoliodon laticaudus*, *Dasyatis zugie* and *Rhynobatus djiddensis* were most dominant in the respective groups. In *dol*/nets, the catch was 30 t (CPUE 7 kg). The size range of *S. laticaudus* was 160-620 mm and *D. imbricatus* 180-



Gearwise effort and catch of elasmobranchs at different centres during 1997

310 mm. Females were dominant in *D. zugie*, *D. uarnak*, *D. imbricatus*, *R. granulatus* and *H. halavi* and males in *S. laticaudus*, *D. bleekeri* and *T. walga* and *R. djiddensis*. Six pregnant specimens of *S. laticaudus* were recorded and a maximum of 6 embryos were obtained from a single shark. Only one embryo was noticed in a female of *D. imbricatus*. The food of *S. laticaudus* consisted of *Coilia dussimieri*, *Trichiurus* sp., crabs, *squilla*, and *Loligo* sp., and that of *D. imbricatus*, *Nematopalaemon tenuipes*, *Solenocera* sp. and *Exhippolismata ensirostris*.

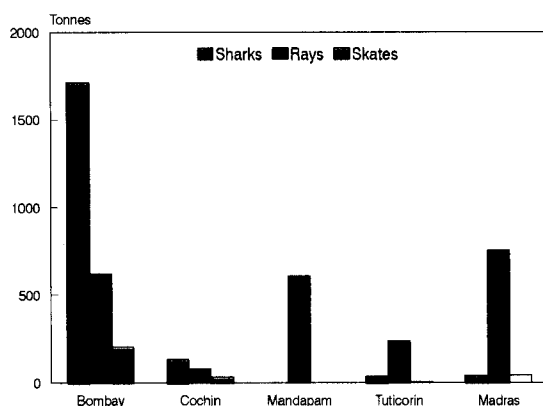
The elasmobranch landing at Cochin was 241 t, of which the contribution of trawlers was 114 t (4 kg /

Unit), drift gill net 106 t (23 kg /unit) and hooks and line was 21 t (21 kg/unit). Sharks formed 55 % of the catch, with *Rhizoprionodon acutus* dominating in all the gears. The size range of *R. acutus* and *Carcharhinus melanopterus* in drift gill net was 40-110 mm.

At Mandapam, the catch of elasmobranchs was 608 t. The trawlers from Rameswaram contributed 552 t (9 kg /unit). *D. sephen* (30 %) was most dominant; the size range was 34 - 210 mm and the male to female ratio was 1: 0.73.

An estimated 282 t was landed at Tuticorin. Trawlers contributed 280 t (51 kg/ unit), bottom set gill net 2 t (60 kg/ unit). Rays formed 85 % of elasmobranchs. *R. acutus* (32 %), *D. bleekeri* (35 %) and *R. anchylostoma* (50 %) were most dominant among sharks, rays and skates respectively.

At Madras, a total of 933 t of elasmobranchs were landed ; trawl contributed 90 % of this group and the drift gill net the rest. Peak catch and catch rates were obtained in March - April and July - August. Rays contributed to the bulk of the catch (90 % of total elasmobranchs) of trawlers.



Landings of Sharks, Rays and Skates at different centres in 1997

MONITORING THE RESOURCE CHARACTERISTICS OF GROUPERS, SNAPPERS AND PIGFACE BREAMS (DF /RE/2)

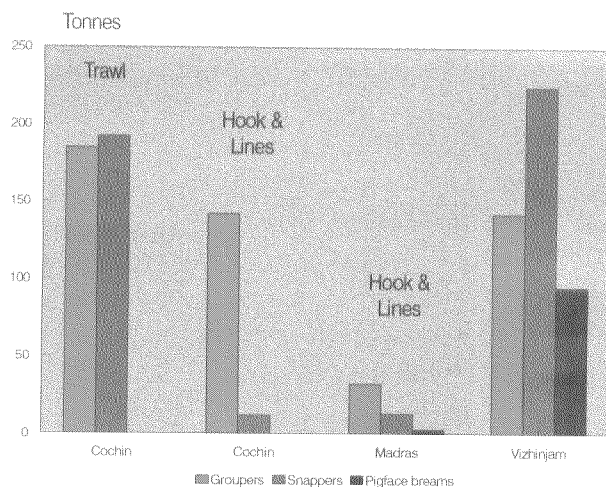
Grace Mathew, S.K. Chakraborty, P. Livingston, K.K. Philipose and P. Nammalwar

The estimated total catch from Bombay, Cochin, Vizhinjam and Madras was 1417 t. The main gears engaged in this fishery were trawl and, hooks and lines from mechanised and non mechanised crafts.

At Bombay 280 t of perches were landed at New Ferry Wharf and Sasoon dock. The major species were *Epinephelus diacanthus* and *Pomadasys* sp in the

trawlers. The fishery showed some improvement over the previous year. The peak landings were in the month of May. *E. diacanthus* was in the size range of 18-32 cm with the mode at 23 cm.

Of the estimated 531 t at Cochin Fisheries Harbour, the trawlers landed 154 t with C/E of 8.6 kg and the hooks and lines 377 t with C/E of 423 kg. *E. diacanthus*



Landings of Groupers, Snappers and Pigface breems at different centres in 1997

was the major species in the trawlers in the length range 12 cm to 39 cm with the average at 20 cm; 75 % of these were immature. The fishery by Hooks and

lines was at its peak in November with C/E of 533 kg. *Pristipomoides typus*, *E. diacanthus*, *E. bleekeri*, *E. chlorostigma*, *E. tauvina* were the dominant species.

At Vizhinjam, hooks and lines by motorised crafts landed 442 t of perches with a C/E of 6.2 kg and 15 t with a C/E of 2.5 kg by nonmotorised craft. Maximum catch was taken during January, February and August. The dominant species were *Lethrinus nebulosus*, *L. lentjan*, *Lutjanus sp.*, *P. typus* and *Epinephelus sp.*

Hooks and lines were the major gear at Madras, landing an estimated 49 t of perches. February and April were the months of peak landings.

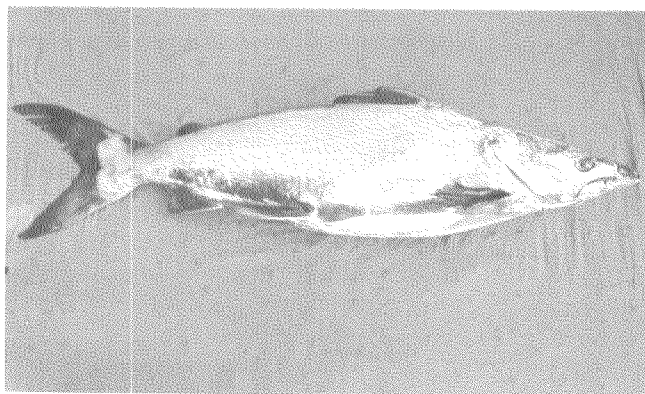
MONITORING THE FISHERY AND BIOLOGICAL CHARACTERISTICS OF CAT FISHES (DF/RE/3)

N.G. Menon, S.G. Raje and P. Nammalwar

The trawlers at Bombay landed 1505 t of catfishes during 1997. The production showed a marginal increase over the previous year. The catch rate was high in the last quarter (50.7 kg/unit). The *Parkawala* landed 18 t while the *Do/net* caught 12 t. The catches of trawl net and *Parkawala* were dominated by *Tachysurus dussumieri* (39 % in the former and 69 % in the latter). The other important species in trawl were *Osteogobius militaris*, *T. coelatus* and *T. sona*. The size range of *O. militaris* in the catch was 140-410 mm in April-September and 180-460 mm in October-December.

The small trawlers at Visakhapatnam landed 22 t comprising, *T. thalassinus*

(82.4 %) and *T. tenuispinis* (17.6%). August-October was the peak period of landing. The entire catch of



Tachysurus serratus

small trawlers belonged to fishes below the size at first maturity. The 'sona' boats landed 5.3 t during August-December 1997 and the catch included 49 t of *T. thalassinus* and 6 t of *T. tenuispinis*.

At Madras, catfish were mainly caught by hooks and line, to the tune of 35 t during 1997. The entire catch consisted of *T. dussumieri* in the size range 250-700 mm and the catch was dominated by fishes in the 590-660 mm length groups.

There was no catfish landing at Cochin in trawlers. The drift netters caught 9 t comprising of *T. thalassinus* (85.7%) and *T. serratus* (14.3%). 65.4% of the total catch was taken during July and August. The entire catch of these two months belonged to mature/ripe fishes. The stock parameters of *T. serratus* were estimated as $L_{\infty} = 140$ cm; $K = 0.3$; $t_0 = -0.3$ yr; $W_{\infty} = 19.97$ kg; $L_m = 60$ cm; $t_r = 1$ yr; $t_c = 1.7$ yrs and the length weight relationship was estimated as $\log W = -3.67954 + 2.5364 \log L$.

DEVELOPMENT OF MANAGEMENT STRATEGIES FOR SUSTAINABLE FISHERY OF THREADFIN BREAMS AND SILVERBELLIES (DF/RE/4)

V.Sriramachandra Murty, S.K. Chakraborty, P.U.Zacharia, K.K.Joshi, E.Vivekanandan, Rekha J.Nair and K.M.S.Ameer Hamsa

THREADFIN BREAMS

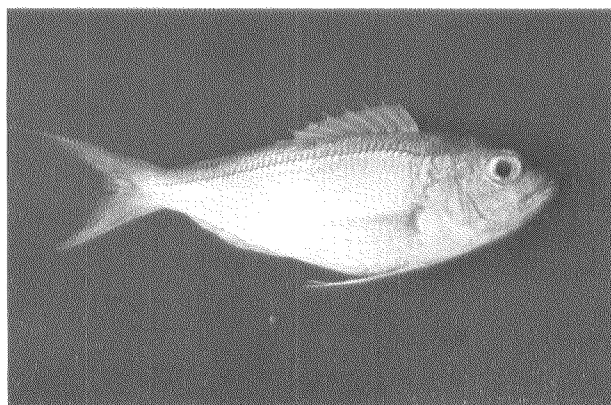
Fishery

The small trawlers at Veraval landed an estimated 3978 t during 1997. The catch rate varied from 0.5 kg in September to 10.6 kg in January. However, maximum effort was expended in November and minimum in September and, maximum catch was obtained in January and minimum in September. *Nemipterus japonicus* was the most dominant species contributing

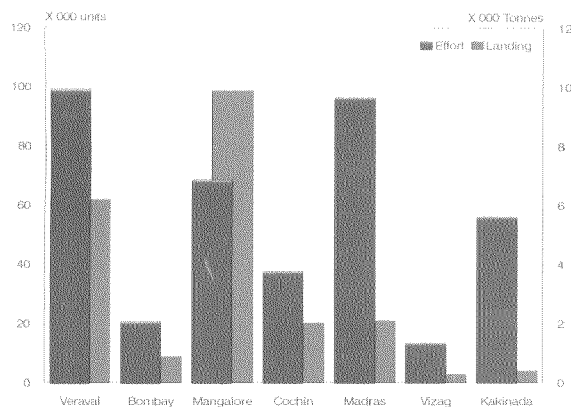
67% of the threadfin bream catch followed by *N.mesoprion* (31%) and *N.delagoae* (2%). However, the catch of *N.mesoprion* was higher than *N.japonicus* in the beginning of the post monsoon period (October) with a catch rate of 47 kg/unit.

At Bombay, the trawlers at New Ferry Wharf landed 1025 t of threadfin brems. The maximum catch and catch rate (400 t, 109 kg) were obtained in March.

At Mangalore and Malpe, the trawlers landed about 9900 t of threadfin brems with an average catch rate of 144 kg per boatday; there was no fishing during July-August at Malpe and during June-August at Mangalore. The effort expended at Mangalore was higher than that at Malpe (the effort at Mangalore was 56% of the total of the two centres) but the landing of threadfin brems at Malpe centre was higher (the threadfin bream catch at Malpe constituted 57% of the total of the two centres). Maximum catch of 1815 t was obtained in September at Mangalore whereas the maximum catch 1856 t was



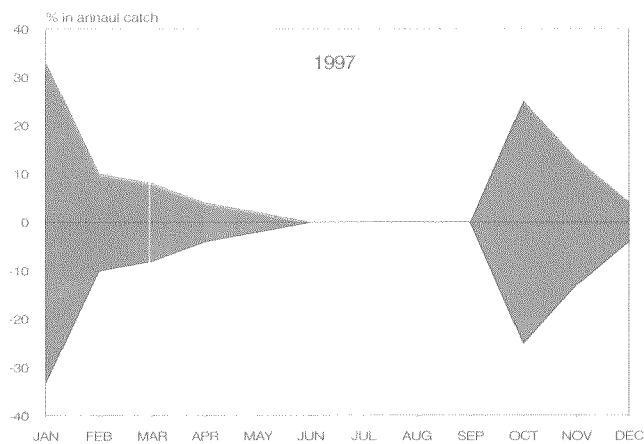
Nemipterus japonicus



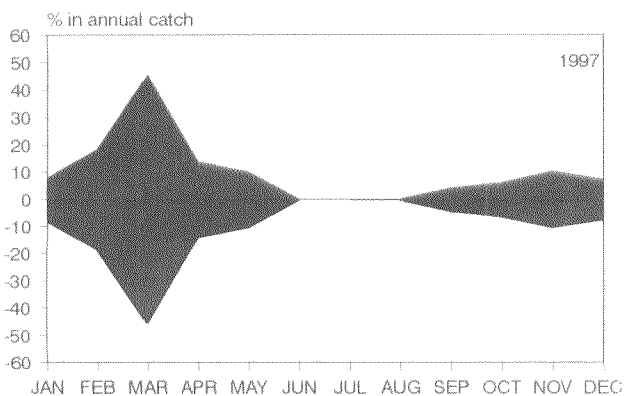
Trawling effort and landing of thread fin breams at different centres during 1997

obtained in May at Malpe. Two species contributed to the fishery at both the centres with more or less the same proportion.

At the Cochin fisheries harbour, an estimated 2495 t of nemipterids were landed by trawlers with an annul C/E of 82 kg. There was no fishing in July. Maximum effort was expended in January but maximum catch and catch rate were obtained in September.



Monthly threadfinbream landings by trawl at Veraval expressed as percentage of annual landings by trawl

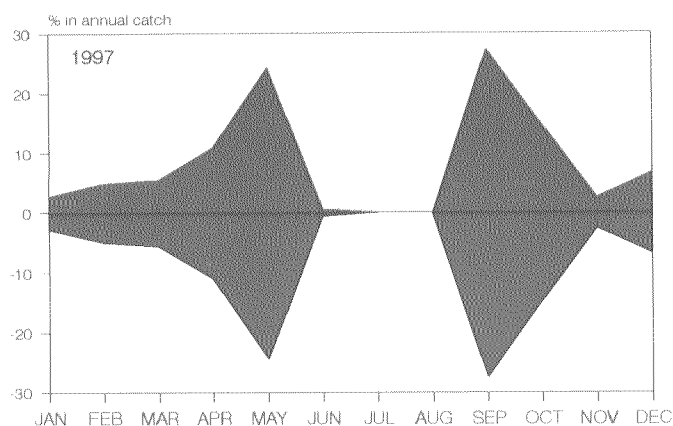


Monthly threadfinbream landings by trawl at Bombay expressed as percentage of annual threadfinbream landings

ber. The catch obtained during August and September formed about 60% of the annual catch of threadfin breams. Four species contributed to the fishery of which *N.mesoprion* was the most dominant, forming 79% of threadfin bream catch followed by *N.japonicus* (12.6%), *N.delagoae* (5.2%) and *N.tolu* (3.3%). The landing of *N.mesoprion* during August and September accounted for 43% of total threadfin bream catch in the year.

At Madras, the trawlers landed 2087 t of nemipterids which formed about 10% of the total trawl catch. The catch/hr of trawling varied from 1.6 kg in December to 4.0 kg in July. At this centre also *N.mesoprion* was most abundant, constituting 38% of total threadfin bream catch followed by *N.japonicus* (27.8%), *N.delagoae* (24.0%) and *N.tolu* (10.2%).

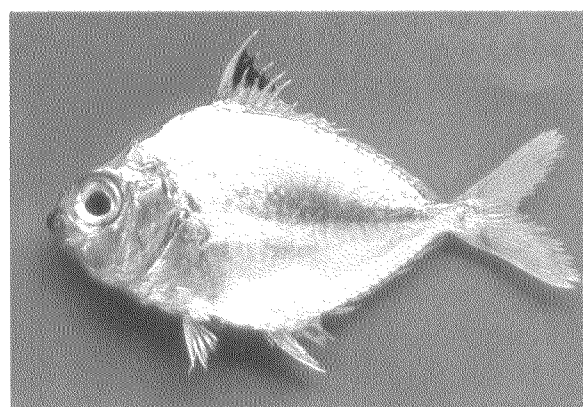
The trawlers at Kakinada landed an estimated 400 t of threadfin breams which formed 14.5% of total trawl catch. *N.japonicus* formed 83% of the threadfin bream catch.



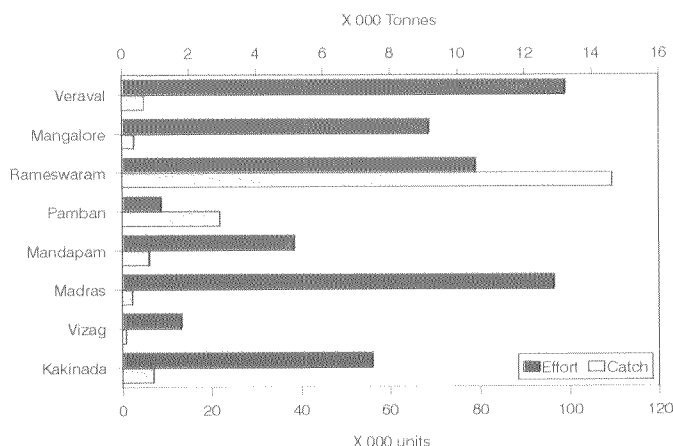
Monthly threadfinbream landings by trawl at Mangalore expressed as percentage of annual landings by trawl

Stock Assessment

The exploitation rates in respect of *N. japonicus* and *N. mesoprion* along Maharashtra coast were estimated as 0.52 and 0.42 respectively suggesting that the exploitation of these species in the present grounds is close to optimal level. Along the coast of Karnataka, the study revealed that maximum sustainable economic yield of *N. japonicus* could be obtained at 80% of the present effort.



Leioagnathus splendens



Trawling effort and landing of silverbellies during 1997

SILVERBELLIES

At Veraval, the trawlers landed 668 t of silverbellies with C/E of 6.7 kg. Maximum C/E was observed during January (11.4 kg) and minimum during September (0.7 Kg).

The trawlers at Mangalore landed 365 t; the C/E ranged from 1.9 kg (October) to 17.0 kg (August). The total landing during the premonsoon months (April-May) was about 50 % of the total landing. The species contributing to the fishery were *S. insidiator*

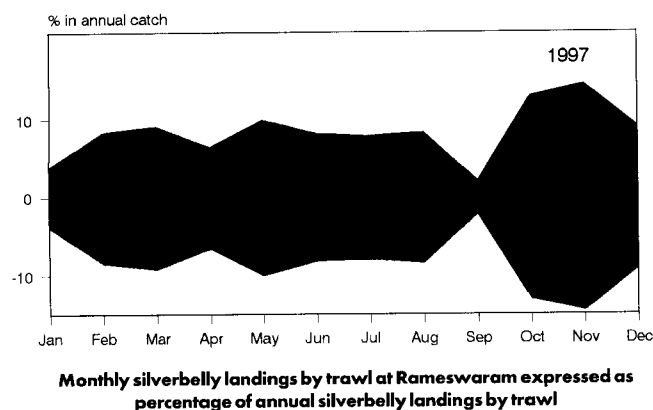
(51.5 %), *L. bindus* (22.8 %) and *L. splendens* (25.7%).

The estimated catch was 19 t at Cochin Fisheries Harbour (C/E 0.73 kg). The catch included *L. bindus* (22.1%) *L. splendens* (21.2 %), *L. equulus* (32.2 %) and *S. insidiator* (24.3 %).

At Madras, the landing of Silverbellies by trawlers was estimated as 3214 t with the monthly C/E of 3.0 - 5.4 kg. The species contributing to the fishery

Length range and dominant lengths of dominant species of threadfin breams and silverbellies in the trawl catches at different Centres

Centre	Species	Length range (mm)	Dominant Length range (mm)
Veraval	<i>N. japonicus</i>	90 - 340	140 - 260
Mangrol	"	110 - 300	150 - 240
Bombay	"	80 - 280	130 - 230
Mangalore	"	100 - 260	150 - 210
Cochin	"	80 - 250	130 - 210
Madras	"	90 - 250	120 - 170
Visakhapatnam	"	120 - 260	140 - 190
Kakinada	<i>N. mesoprion</i>	30 - 300	120 - 220
Bombay	"	60 - 260	110 - 190
Mangalore	"	100 - 250	120 - 190
Cochin	"	60 - 290	120 - 200
Mangalore	<i>S. insidiator</i>	70 - 110	85 - 100
Cochin	"	65 - 105	80 - 95
Pamban	"	85 - 100	90 - 100
Visakhapatnam	"	65 - 110	75 - 105
Kakinada	"	35 - 125	65 - 95
Mangalore	<i>L. bindus</i>	70 - 110	85 - 100
Cochin	"	35 - 100	50 - 80
Madras	"	60 - 110	80 - 95
Visakhapatnam	"	60 - 120	75 - 100
Kakinada	"	35 - 125	50 - 85
Cochin	<i>L. splendens</i>	80 - 105	85 - 100
Cochin	<i>G. minuta</i>	70 - 100	80 - 95
Visakhapatnam	"	70 - 125	80 - 100
Rameswaram	<i>L. brevirostris</i>	50 - 130	80 - 105
Pamban	<i>L. berbis</i>	65 - 105	80 - 95
Rameswaram	"	60 - 100	75 - 90
Rameswaram	<i>L. jonesi</i>	45 - 120	70 - 90
Pamban	<i>L. dussumieri</i>	50 - 130	80 - 105



included *L. bindus* (31.3%), *L. splendens* (14.5%), *S. insidiator* (24.0%), *L. leusiscus* (7.7%), *L. lineolatus* (5.4%) and others.

In the Mandapam region, the trawlers landed an estimated 25607 t (Mandapam, Rameswaram and Pamban); the landings in the region suggest that these

fishes are more abundant in the Palk Bay as evidenced by comparatively poor landing at Pamban (Gulf of Mannar). In October-November, these fishes are more abundant in fishing grounds of Palk Bay whereas in the Gulf of Mannar, they are abundant in February-March.

The estimated landing by trawlers at Visakhapatnam was 128t and C/E varied from 7.4 kg to 41.4 kg. The major species contributing to the fishery were *L. bindus* (41.5%), *S. insidiator* (20.0%) and *G. minuta* (14.2%).

At Kakinada the trawlers landed 926 t of silverbellies. Important species contributing to the fishery included *L. bindus* (17.2%), *L. splendens* (19.1%), *L. equulus* (11.3%), *S. insidiator* (11.7%) and *G. minuta* (26.1%).

DEVELOPMENT OF MANAGEMENT STRATEGIES FOR JUDICIOUS EXPLOITATION OF SCIAENIDS (DF/RE/5)

S.K.Chakraborty, M. Feroze khan, S.Sivakami, P. Livingston, Rekha J.Nair, P. Devadoss and K.M.S.Ameer Hamsa

Landings of Sciaenid fishes at different centres

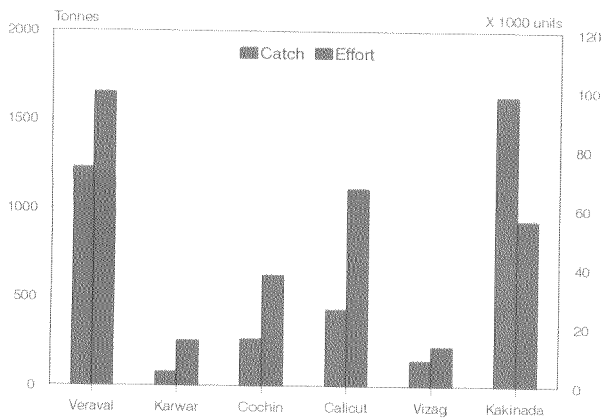
Centre	Catch in tonnes	Average catch per boat (Kg)
Veraval	12700	76.40
Bombay	30917	97.71
Karwar	1019	29.31
Calicut	431	10.04
Cochin	297	10.02
Mandapam	320	8.76
Madras	617	23.34
Visakhapatnam	207	15.59
Kakinada	1630	37.22

At Bombay, Calicut, Cochin, Mandapam, Kakinada and Vishakapatnam the catches were exclusively by trawlers. At Veraval nearly 88% of the catch was from trawlers and rest from gillnets and do/nets. At Karwar, nearly 76% of the catch was from trawlers and rest from shoreseines.

There was no major change in craft and gears, area and depth of operation and the cod end mesh size of the trawlers during the period under report.

Important species contributing to the fishery

Veraval: *Otolithes cuvieri* was the dominant species,



Trawling effort and catch of sciaenids at different centers in 1997

followed by *Johnius glaucus*. The other species in order of abundance were *Johnnieops vogleri*, *O. ruber*, *J. macrorhynchus*, *O. biauritus* and *P. diacanthus*.

Bombay: *O. cuvieri* was the dominant species followed by *J. vogleri* and *J. macrorhynchus*. The other sciaenids in order of abundance were *J. sina*, *P. macrophthalmus* and *J. dussumieri*, *J. glaucus* and *J. elongatus*.

Karwar: *O. cuvieri* was the dominant species followed by *J. coitor*.

Calicut: *J. sina* was the dominant species followed by *J. belangerii*, *J. aneus* and *O. argenteus*.

Cochin: *J. sina* was the dominant species followed by *O. ruber*.

Mandapam: *N. maculata* and *P. macrophthalmus* were the dominant species.

Madras: *J. carutta* was the dominant species followed by *O. ruber*.

Visakhapatnam: *J. amblycephalus* was the dominant species followed by *J. carutta*, *J. dussumieri* and *N. maculata*.

Kakinada: *O. ruber* was the most dominant species followed by *N. maculata* and *J. carutta*.

Biology and stock assessment

Veraval: Length of *O. cuvieri* ranged from 88 to 310 mm, *J. glaucus* 70 to 270 mm and *P. diacanthus* from 260 to 1162 mm.

Bombay: The size range of *J. macrorhynchus* was 128-298 mm, *J. vogleri* 130-308 mm. *O. cuvieri* which grows to relatively larger size was recorded in the length range 120-365 mm. *J. sina* was recorded in the length range of 84-205 mm, *P. macrophthalmus* in 90-235 mm and *J. dussumieri* in 130-270 mm. *O. biauritus* was recorded in the length range of 236-

1580 mm.

Mature females of *J. sina* were recorded in March-April period and spent females in October-November period. Based on the data of 1997, the mortality and population parameters of six species of sciaenids were estimated.

Karwar: Mostly maturing specimens of *O. cuvieri* were caught. The length range was 60-190 mm. The length range of *J. coitor* was 75-274 mm, nearly 10% of the females were in gravid condition and mature fe-



Otolithus ruber

males were recorded in greater quantities in October-December period.

Calicut: The length range of *J. sina* was 70-160 mm. Males were dominant in the fishery. Mature females were abundant in January, April and September.

Cochin: *J. sina* was in the length range of 80-190 mm with 121-140 mm forming the mainstay of the fishery. Mature females were recorded in January, September and December. The male:female ratio was 1:2. *O. ruber* was recorded in the length range of 80-240 mm, mature females were recorded in December.

Mandapam: Size of *P. macrophthalmus* ranged

from 120 to 190 mm and that of *N. maculata* from 110 to 180 mm. Females were dominant in *N. maculata* most of the specimens examined had empty stomachs.

Visakhapatnam: The size range of *J. carutta* was 105-210 mm. Mature females were recorded in April-September period. *Squilla*, crabs, brittlestar and amphipods were the chief food items.

Kakinada: The length of *N. maculata* ranged from 75 to 285 mm. Juveniles were recorded in October. Sex ratio was found to be 1:1. Stomatopods, prawns and crabs formed the chief food items.

Population parameters of Sciaenid species exploited off Bombay (New Ferry Wharf)

Species	Z	M	F	E	U	Yield (t)	Total stock (t)
<i>J. macrorhynchus</i>	3.38	1.14	2.24	0.66	0.63	895	1421
<i>J. vogleri</i>	1.97	1.26	0.71	0.36	0.30	1059	3530
<i>O. cuvieri</i>	1.98	0.88	1.10	0.55	0.47	1094	2327
<i>J. sina</i>	3.68	1.80	1.88	0.51	0.49	614	1253
<i>P. macrophthalmus</i>	2.42	1.83	0.59	0.24	0.21	42	201
<i>J. dussumieri</i>	1.86	1.03	0.83	0.44	0.37	52	142

RESOURCE CHARACTERISTICS AND BIOLOGY OF LIZARD FISHES, THREADFINS, POMFRETS AND BULL'S EYE (DF/RE/6)

S. Sivakami, E. Vivekanandan, S.G. Raju, M. Feroze Khan and K.M.S.A Hamsa

LIZARD FISHES

1. Exploitation

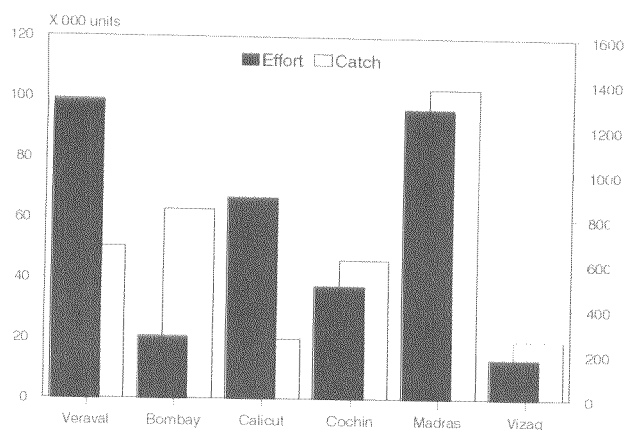
Lizard fish landings during 1997 increased at Veraval (70.6%), Mangrol (4%), Bombay (53.4%), Cochin (14.5%) and Visakhapatnam (71%) and decreased at Calicut - Puthiappa (47%), Beypore (63%) and Madras (48%) when compared to 1996. There was increase in effort at Veraval (22%), Mangrol (14%), Bombay (13.7) and Cochin (9.23%), and decrease at Beypore (3.4%) and Visakhapatnam (28.2%). At Visakhapatnam, another 100 t (0.33 kg/E) of lizard fish was landed by *Sona* boats.

2. Seasonal abundance

At Veraval and Mangrol, October-January was the period of abundance (June-August: no trawling), April/May and September at Bombay and July-September at Calicut, Cochin, Madras and Visakhapatnam.

3. Species composition

Saurida tumbil constituted 83% of the total lizard fish catch both at Veraval and Mangrol, 77% at Bombay and 100% at Calicut while *S. undosquamis* formed 79% at Cochin, 71% at Visakhapatnam and 100% at Madras.



Trawling effort and landings of lizardfish during 1997

4. Length composition

i. *S. tumbil*: At Veraval the size range was 165-555 mm but fish of the size range 275 - 325 mm formed 55% of the total catch. At Mangrol length range was 205 - 475 mm with the fishes in the length range 285-345mm contributed to about 60% of the catch. The length range at Calicut was 175-385 mm with 205-245 mm dominating. At Bombay, fishes of the length range 195-295 mm formed 75% of the catch though the range in the catch was 115-415 mm. At Cochin, 69% of the catch belonged to the length range 475-525 mm.

ii. *S. undosquamis*: At Cochin the length range was 135-325 mm and 215-255 mm size groups dominated. At Madras the size groups between 165 - 205 mm formed 62% of the catch. At Visakhapatnam the size groups 175 - 205 mm formed 69.5% of the catch.

5. Food

Lizard fishes in general were found to feed on fishes such as *Decapterus* spp and *Nemipterus* spp, Crustaceans (*P. stylifera* spp and cephalopods (*Loligo* spp., *Sepia* spp)

BULL'S EYE

1. Exploitation

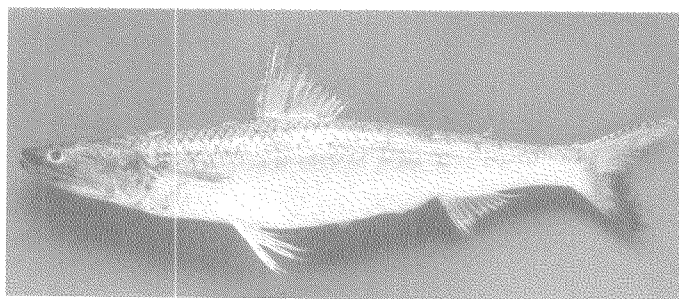
Bull's eye landings increased in all the centres monitored (347% at Veraval, 266% at Mangrol, 757% at Calicut (Puthiappa) 364% at Beypore, 52% at Cochin, and by 170% at Visakhapatnam). However, the catch showed a marginal decline (16%) at Madras.

2. Seasonal abundance

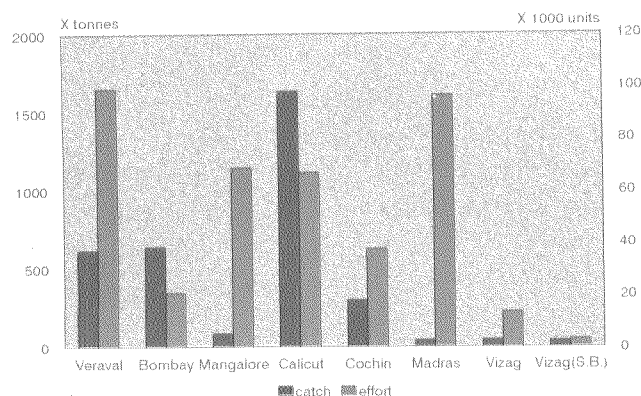
At Veraval, high catch rates were obtained during January-March, and during February-March at Mangrol. At Bombay, both at New Ferry Wharf and at Sasoon Dock, better catch rates were obtained during February - May. At Calicut, January-February brought better catch rates, while at Cochin and Visakhapatnam, June, July and September were the peak months.

3. Size frequency distribution

In *P. hamrur*, fish of length range 195 - 245 mm formed 69.7% of catch at Bombay; at Cochin fishes of 215 - 255 mm length range formed 71.4% of the catch.



Saurida undosquamis

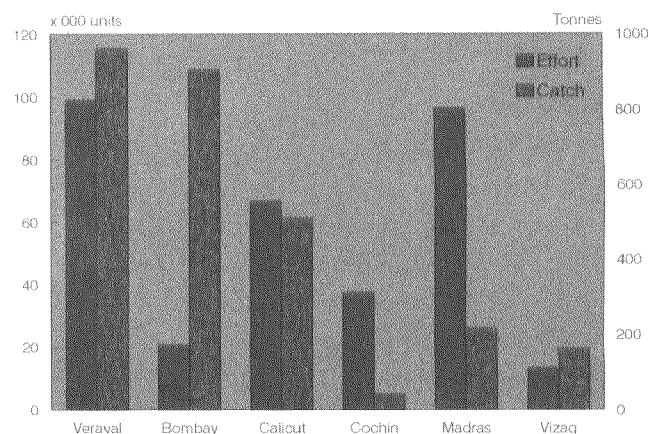


Trawling effort and landings of Bull's eye at different centres during 1997

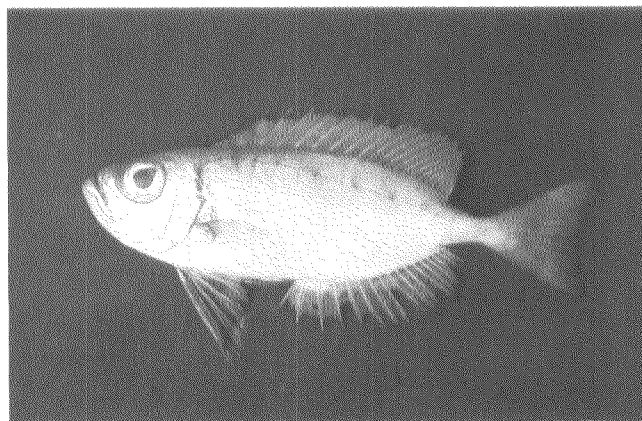
POMFRETS

1. Exploitation

Fishery of pomfrets also showed an increase in all the centres (33% at Veraval and Mangrol, 288% at Bombay-NFW, 450% at Versova-dol net, 795% at Calicut-Puthiappa), 276% at Beypore, 2160 % at Cochin-trawl, 156% at Madras and 78% at Visakhapatnam - trawl).



Trawling effort and landings of pomfrets during 1997


Priacanthus hamrur

At Bombay (Satpati), an estimated 554 t (274.22 kg/E; 2019 units) of pomfrets were landed in gill nets during October - December months. At Cochin, an estimated 34 t was landed in September 1997 by purseseine.

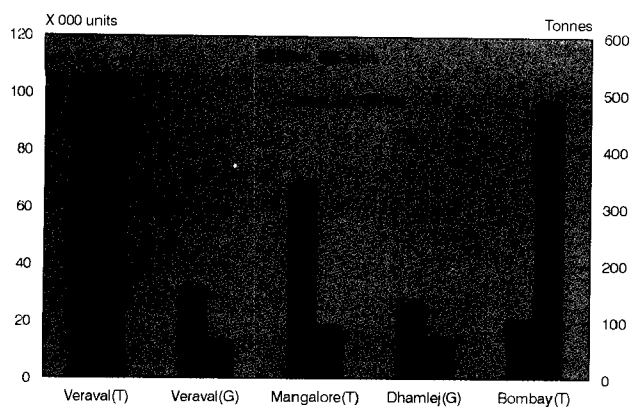
2. Seasonal abundance

At Veraval, Mangrol and Bombay, first and last quarters brought higher catch rates, while at Calicut June-September was the peak period. At Cochin, maximum

catch rate of 32 kg was obtained during October. At Visakhapatnam, in " Sona" boat, higher catch rates were noticed during October-December months.

3. Species composition

Pampus argenteus was the dominant species at Bombay (NFW), Versova (dol net), Satpati (gill net), Calicut, and Visakhapatnam (Sona boat) forming 62%, 97%, 86%, 67%, 71% and 78% of the pomfret catch respectively.



Gearwise effort and catch of threadfins at different centres during 1997

Formio niger contributed to 57% at Cochin, 55% at Visakhapatnam (Trawl), 38% at Bombay (NFW) and 30-33% at Calicut.

In purseseine at Cochin, the pomfret landing during September 97 was solely represented by *F. niger*

4. Size frequency distribution

Length frequency data of *F. niger* in different months at Calicut showed modes at 165, 175, 185, 215 and 245 mm. At Cochin, *P. argenteus* landed showed modes at 185, 205, 245, 275 and 305 mm in the trawl catch.

THREADFINS

1. Exploitation

At Veraval, the polynemid landing by trawl increased by 72% with an effort increase of 22%. However, in gill net, the catch decreased by 49.7% though the effort increased by 5.8%. At Mangrol, the catch in trawl increased by 28.2% with an increase in effort of 14%. At Dhamlej, in gill net, the polynemid catch showed a decline of 41% though the effort increased by 8%.

2. Seasonal abundance

At Veraval, higher catch rate of 21.3 kg was obtained during January 97, while in gill net, month of July brought the maximum catch rates at Veraval (8.92 kg/E) and Dhamlej (12.12 kg/E). October - December period was the peak period for polynemids at Mangrol in trawl. At Bombay (NFW), March - May brought higher catch rates in trawl.

3. Species composition

At Veraval, Mangrol, Dhamlej and Bombay, *Polynemus indicus* constituted 54%, 67%, 65% and 40% respectively. *Eleutheronema tetradactylum* formed 32.6% at Bombay, 21.4% at Veraval and 19% at Dhamlej. Other species represented were *P. heptadactylus*, *P. plebius* and *P. sextarius*

4. Size frequency distribution

In *P. indicus* caught in trawl at Veraval the length range was 290-890mm, with the 350-410 mm range forming 40%. At Dhamlej, the catch in gillnet was in the length range of 230-690 mm, with 310-370 mm and 410-490 mm forming 35% and 31% of total respectively.

P. heptadactylus caught in trawl at Bombay (85-205 mm) had the size groups 95-125 mm forming 77.3%, while the species caught in gill net (85-305 mm) at Satpati had the size groups 125-145 mm forming 42% of total landing.

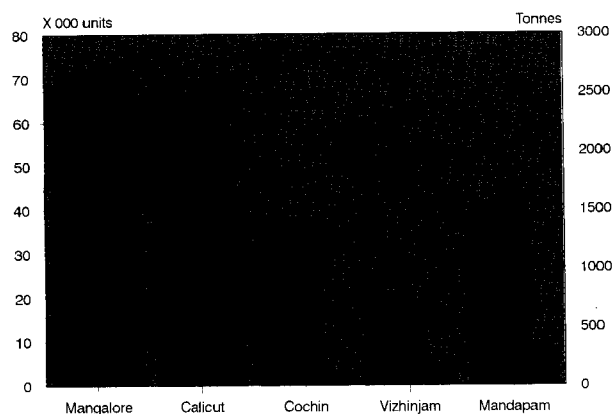
BIOLOGY AND FISHERY OF FLATFISHES, GOATFISHES AND WHITEFISH (DF/RE\7)

E. Vivekanandan, P. Bensam, P. U. Zacharia, M. Ferozekhan, S. Krishnapillai,
K. M. S. Ameer Hamsa and Rekha J. Nair

The project was implemented at three centres along the east coast and four along the west coast.

FLATFISH

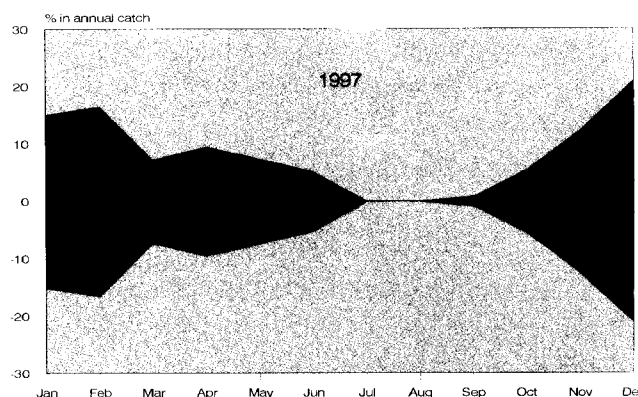
At Mangalore and Malpe, the estimated landings



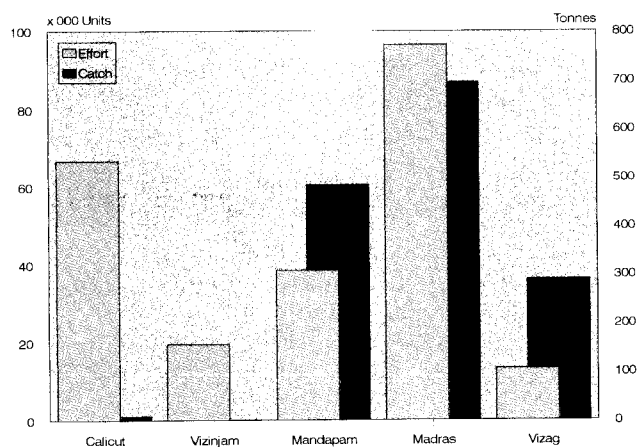
Trawling effort and landings of flatfish at different centres during 1997

by trawlers were 2690 t with peak landings during January-March and November-December. Of the three species caught *Cynoglossus macrostomus* was the most dominant forming over 90% of flatfish catch. The length range in the catch was 60-169 mm; fishes in maturing and mature codition were dominant during April-December.

At Calicut, the trawlers landed an estimated 1670 t of flatfish; January-February and November-December were



Monthly flatfish landings by trawl at Calicut expressed as percentage of annual flatfish landings by trawl



Effort and landing of goatfish by trawlers at different centres during 1997

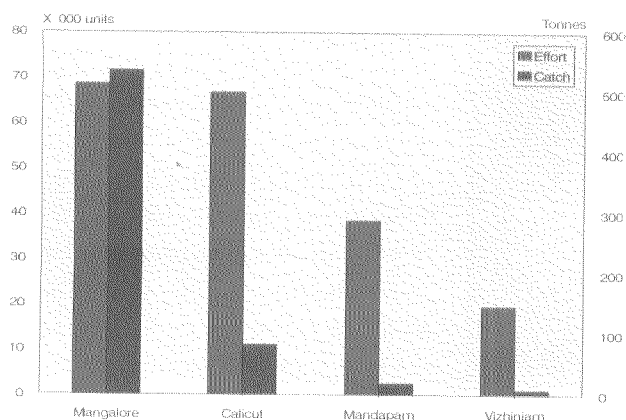
peak periods for the landings. At this centre also 3 species contributed to the fishery and *C. macrolepidotus* was the most dominant species; the catch of this species was in the length range of 80-149 mm and immature fish were most abundant.

The flatfish landing at Cochin was estimated at 100 t with peak in January. In the Mandapam region an estimated 410 t of flatfish were landed by trawlers with peak landing during June - August. Five

species contributed to the fishery of which *C. macrolepidotus* was most abundant forming about 43 % of flat fish catch. The length range in the catch was 160-410 mm.

GOATFISH

The trawlers at Visakhaptnam landed about 489 t of goatfish of which the Sona boats contributed 59 %. Peak catches were obtained in July -October and December by small trawlers and in April, August, October and December by Sona boats. *Upeneus vittatus* was the dominant species; with the length range in the catch at 90-189



Effort and catch of whitefish by trawlers at different centres during 1997

mm. Mature fish were abundant during April-September and immature during October-December.

At Madras about 700 t of goatfish were landed by trawlers. *U. sulphureus* and *U. maluccensis* were most abundant. In *U. sulphureus* the length range was 110-169 mm and most of them were in early maturing stage.

The small trawlers in the Mandapam region landed 470 t of goatfish; maximum landings were obtained during June-October period. A total of 7 species contributed to the fishery of which *U. sundaicus* was most dominant accounting for 50 % of goatfish catch. The length range in the catch was 90-189 mm and most of fishes were in mature condition during April-December.

WHITEFISH

At Mangalore the estimated catch was 540 t; maximum catch was obtained during April-May. The landings registered substantial increase over those of previous year. The length range in the catch was 80 -209 mm and mature fish were abundant during April-December. The estimated catch was about 80 t at Calicut with peak landing in June. At Vizhinjam only 8 t of *Lactarius* of the length range 115-160 mm was landed.

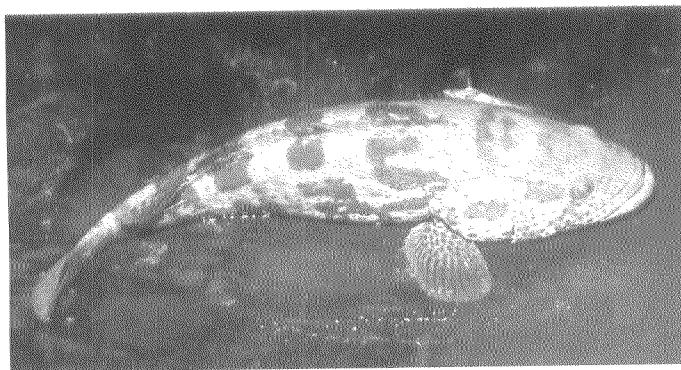
CULTURE OF GROUPERS, SEABASS, RABBITFISH AND ORNAMENTAL FISH (DF/CUL/3)

K. V. Somasekharan Nair, V. S. Rengaswamy, D. C. V. Easterson, A. Raju, D. Kandaswamy, I. Jagadish, Grace Mathew, N. Sridhar, Manpal Sridhar, Molly Varghese, P. P. Manojkumar and Miriam Paul

COCHIN

Seventeen juveniles of *E. malabaricus* of average length 185 mm (range 110-210 mm) and average weight 136 g (range 50-200 g) collected from the wild were stocked in 5 tonne FRP tanks (4.9 Sq. m. bottom area) in recirculating water in March 1996. These fishes have grown to a length of 280 to 350 mm (315 mm) and a weight of 1500 to 1800 g (1650g) in the first year. These were fed with fish (*Nemipterus* spp., *Upeneus* spp., sciaenids, sardines small prawns, small squids etc.)

to satiation point, which was 4-5% of the body weight of the fish. This experiment was continued during 1997 also. During this year, the water temperature, salinity, dissolved oxygen, pH and ammonia levels in the water were monitored at weekly intervals. The water temperature ranged from a minimum of 26° C in September to a maximum of 28.5° C in April. The salinity was maintained between 28 and 33.5 ppt and dissolved oxygen between 3.5 and 4.7 ml/L. The ammonia concentration which was relatively high during April-July 1997 (0.78

*Epinephelus malabaricus*

to 1.42 mg/L) could be brought down to 0.003 mg/L by improving the efficiency of biofilter system. By the end of February 1998, i.e., after another year, the fishes attained average weight of 2900 g registering a weight gain of 1250g by the second year end. The groupers raised and maintained in the laboratory were found to be healthy and free from diseases. The fishes were treated with potassium permanganate or dilute formaldehyde solution bath to guard against protozoan and fungal infection.

Two fishes of total length 54 cm and 50 cm and weight 2.9 kg and 2.45 kg were given oral administration (through food fish) of 17-methyl testosterone in the form of pellets with cholesterol base. The dosage was 5 mg of hormone per fish. The fishes were found to be more active after the initial doses were given. After five weeks, the two fishes attained a weight gain of 600 g and 550 g respectively.

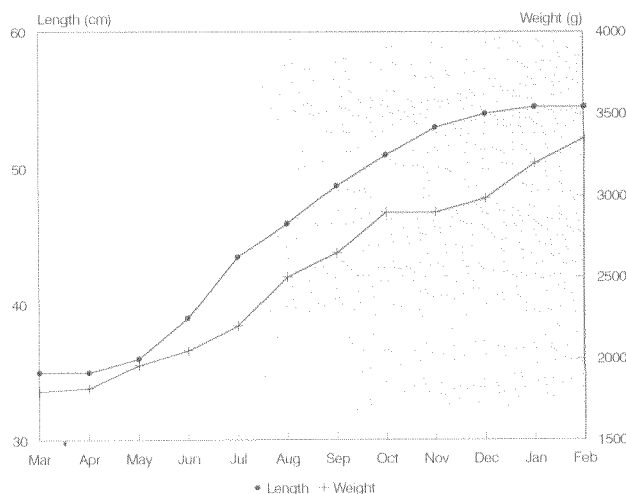
A group of juveniles (17 numbers) collected from the wild were stocked in a 5-t capacity FRP tank (4.9 sq m. bottom area) in March 97 and were given fish at the rate of 5 % of body weight. The mean size at stocking was 185 mm (100 g). By

February 1998 the mean length increased to 377 mm and mean weight to 1010 g registering an average monthly growth rate of 75 g/6 mm. The water temperature, salinity, dissolved oxygen, pH and ammonia concentration were regularly monitored. Since these fishes are also maintained in a recirculating system using biofilters, the water quality parameters could be regulated to a large extent and the entire brood stock (17 nos) were found to be healthy.

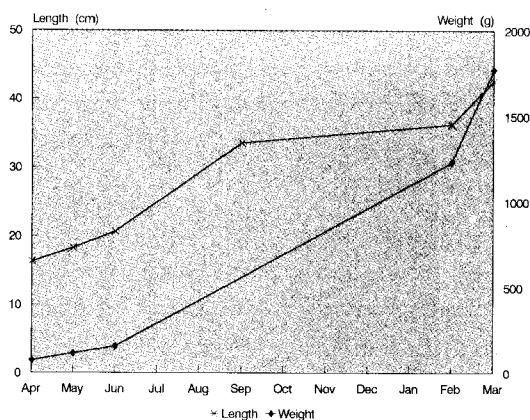
NARAKKAL

At Narakkal, *Epinephelus tauvina* was reared in silpaulin-lined ponds and earthen ponds. They were fed with live prawns, small *Tilapia* sp and *Eetroplus maculatus* at the rate of 8-10% of their body weight, daily in the morning. The mean size of the fishes stocked in silpaulin ponds in March 1997 was 163 mm (74 g) which increased to 425 mm (1770 g) by March 1998, registering a weight gain of 1696 g.

Juveniles of *E. malabaricus* (23 nos) of mean length of 183 mm (137.9 g) were also stocked in the earthen ponds at Narakkal. They have grown to a mean size of



Growth in length and weight of *E. malabaricus* in a 5-t FRP tank during March 97-February 98



Growth in length and weight of *E. malabaricus* in a silpaulin-lined pond at Narakkal during April 97 - March 98

442 mm (1780 g) by March 1998. The hydrographical parameters of the earthen ponds exhibited an almost identical pattern as in silpaulin ponds. The salinity in the earthen ponds during monsoon came down to 4.9 ppt and the dissolved oxygen to 1.2 ml/L in July and August, resulting in the mortality of 8 fishes in the pond.

Attempts were made for the induced maturation of groupers using 17-methyl testosterone. Two specimens weighing 2.5 kg each were selected and kept separately in a 70-tonne silpaulin pond and oral administration of the hormone was started in January 1998. The pellets prepared were inserted inside the mouth of the food fish (*E. maculatus*) and fed. It has been noticed that the fishes started taking more food after oral administration of the hormone.

As groupers are carnivorous, more animal protein is required in the diet for both growth and maturation. The possible food items for inducing maturation and spawning were identified as shrimp meal, squid meal and blood worms in addition to trash fish. Other requirements were P-

carotene, canthaxanthin or astaxanthin, vitamin E and n - 3 fatty acids. The protein sources were collected, dried and powdered and their proximate composition analysed.

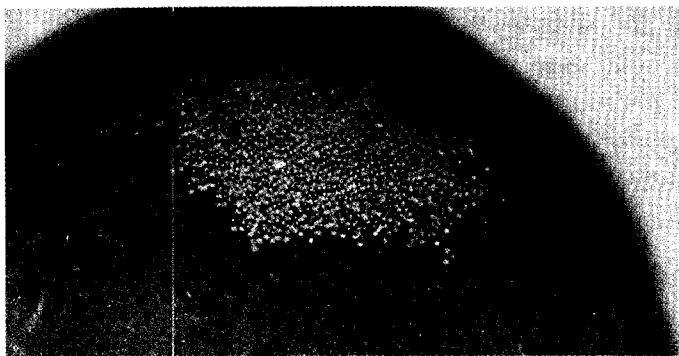
A few fingerlings of the grouper *E. diacanthus* ranging in length from 85 to 102 mm and 6.9 to 16.4 g were sacrificed and analysed for their carcass composition for understanding the nutritional requirements of the species. The carcass composition of the fingerlings is: dry matter 87.87%, crude protein 62.00%, ether extract 13.66% and ash 26.6%. During the year, the procedure

for estimating alkaline, acidic and neutral proteases was standardised using a modification of the casein hydrolysis method.

MANDAPAM

During the year under report, 179 specimens of *Epinephelus tauvina* were collected from the wild and transported to the experimental site.

The groupers were segregated into two groups; one of specimens of 430 - 730 mm length and 1.0 - 6.0 kg weight and the other of those weighing less than



Eggs of down fish at Vizhinjam laboratory

1 kg. The former were stocked in 60 t capacity cement tanks and the latter in 40 t tanks. The tanks were cleaned twice in a week and 100% exchange of fresh sea water was ensured in addition to 50% exchange daily. The salinity ranged from 30 to 32 ppt. The fishes were given fresh sardines at the rate of 6-10% of body weight. The feed conversion ratio was 55:1 (ie, 55 g of feed was required for 1 g of weight increase) in the 60-t tank, whereas the same in the 40 tonne tank was 18:1.

240 specimens of grouper (average length 69.8 mm, average weight 4.5 g) collected from the estuarine region of Thamraparni river were stocked in 30-tonne capacity outdoor tank and chopped sardines at the rate of 10% of body weight were given as food. These fishes showed an average increment of 1.87 mm and 1.26 g per day. The grouper fingerlings stocked with an initial mean size of 69.8 mm (4.5 g) had grown to an average size of 150.2 mm (52.2 g), 210.6 mm (117.7 g) and 211.2 mm (175 g) in October, November and December respectively.

A floating netcage of size 4 x 4 x 2.5 m was fabricated using palmyrah frames as raft and polyvinyl cylindrical drums as floats and anchored at a depth of 3 m in the Gulf of Mannar. The netcage was stocked with 6 numbers of groupers.

Mortality was minimised to a large extent by avoiding frequent handling and by giving antibiotic treatment with acriflavin, malachite green and potassium permanganate solution.

30 numbers of the rabbitfish *Siganus javus* collected from wild were maintained in 5 tonne FRP tanks by feeding them with filamentous algae *Enteromorpha* sp. and *Gracilaria* sp.

TUTICORIN

Attempts were made to collect seed as well as adult groupers, rabbit fish and ornamental fish from Vellapatti, harbour Point, Palayakayal and Punnaikayal areas for developing broodstock. Grouper seed was available almost throughout the year at Vellapatti area. In July 1997, 185 seed were sent to Cochin and 230 in August to Mandapam. In all the cases 100% survival was noticed. From October to February, 400 grouper seed were collected and stocked in ponds near Karapad laboratory.

The rearing experiments were conducted in earthen ponds and the groupers were fed with fresh trash fish at the rate of 5-10 % of the body weight. The fish stocked during August - November 1996 grew to a size of 290 - 500 mm (average 390 mm) and weighed 310 - 950 g (average 530g). The monthly average growth rate was 15 mm (40.8 g). The salinity in the pond was reduced from 34 ppt in October to 28 ppt in December.

About 45 numbers of rabbitfish (*Siganus* sp.) seed collected from Karappad area were maintained in 1-t capacity FRP tanks. 54 numbers were also transported from Mandapam. Though the seed was fed with filamentous algae, only few numbers survived due to injury at the time of capture.

INVESTIGATIONS ON THE IMPACT OF COASTAL BOTTOM TRAWLING ON DEMERSAL FISHES AND MACROBENTHOS (DF/TR/1)

N. G. Menon, P. Nammalwar, P. U. Zacharia and I. Jagadish

The bottom trawl fisheries in Kerala, Karnataka, Tamil Nadu and Andhra Pradesh yielded the target resources (crustaceans and cephalopods) only to the

tune of 17.2 % of the total catch. Finfishes formed 73.8 % and benthic biota 9% of the total landing. The target landing of resources was high in Andhra Pradesh

(29.3%) and Karnataka (21%) whereas the benthic biota occurred abundantly in the trawl landings of Karnataka (14.4%) and Tamil Nadu (11%).

The trawlers at Cochin fisheries harbour landed 12170 t of bycatch of finfishes and 2.4 t (0.2%) of benthic biota such as stomatopods, gastropods, bivalves, echinoderms and inedible crabs. Young ones of sciaenids, whitefish, silverbellies, groupers, threadfin breams and lizard fishes formed 0.8 - 3 % of the total finfish catch. The annual estimated juvenile finfish catch was 183 t. The young fishes dominated the catches of August-October. The landing of benthic biota was high during January-March when the fishing was intense in shallow grounds.

Experimental bottom trawling conducted along 15-30 m depth off cochin by Cadalmin during May, June, October, November 1997 revealed that this region is abundant in sciaenids, perches, flatfishes, silverbellies, whitefish, carangids, etc. The high percentage of benthic biota in experimental trawling is due to fishing in shallow grounds compared to commercial trawling.

During the period under report, the single day trawl fishing off Mangalore and Malpe in depths less than 30 m resulted in the landing of 2682 t of benthic biota (40.5% of total) consisting of *squilla* (100%). Young fishes of *Lactarius* (25-119 mm), sciaenids, flatfishes, silverbellies and others formed about 5-8% of the total finfish catch.

Results of experimental trawling conducted by Cadalmin off Cochin in 15-30 m depth.

	May	June	October	November
Percentage in total catch				
Finfishes	53.0	63.0	94.7	51.0
Crustaceans & Cephalopods	27.3	25.6	4.8	32.1
Benthic biota	19.7	11.4	0.5	16.5
Percentage in finfish catch				
Juvenile fish	19.3	14.0	20.0	13.0

The trawlers operating in depths above 30 m (multiday fishing) landed 1669 t of benthic biota comprising *Squilla* (85%) gastropods (4.4%), bivalves (3.7%), inedible crabs and fishes (6.2%), echinoderms etc. About 3-5 % of the finfishes consisted of juvenile threadfin breams (100-140 mm) lizardfish (55-89mm) sciaenids (55-89) *Epinephelus diacanthus* (100-140 mm) and others.

During January-September 1997, the trawlers operating in the depths of 30-90 m in Gulf of Mannar landed 363 of benthic biota consisting of inedible crabs, echinoderms, stomatopods, bivalves together with sea weeds and sea grasses. Young/juveniles of goatfishes, sciaenids, silverbellies catfishes occurred in the catches to the tune of 5-10 % of the finfish catch. The trawlers operating in depths upto 12 m in the Palk Bay landed 4254 t (14.2%) of benthic biota consisting of such as inedible crabs, jellyfishes, echinoderms, stomatopods, bivalves, gastropods etc. The young fish component was represented by catfishes, sciaenids, flatfishes and silverbellies.

During the second and fourth quarters of 1997 the trawl landing at Madras consisted of benthic organisms to the tune of 17 % of total catch comprising of *Squilla*, gastropods, inedible crabs and echinoderms.

The total trawl catch of 6840 t at Karwar and Tadri consisted of 2381 t (34.8 %) of benthic nonedible organisms chiefly *Squilla*. The trawl catch also included young fishes of *Lactarius* (85-140 m), *Cynoglossus* (60-74), sciaenids, silverbellies etc.

The trawlers at Kakinada landed 542 t of benthic biota consisting of stomatopods, inedible crabs, bivalves, gastropods, echinoderms, sponges etc. The finfish catch also included 5-10 % of young /juveniles of sciaenids, flatfishes, perches, threadfin bream, lizard fishes and goatfishes.

IV. CRUSTACEAN FISHERIES DIVISION

The total marine crustacean production in the country in 1997 was estimated at 5,03,150 t showing an increase of 26.3% over the previous year. Crustaceans contributed to 18.6% of the all India marine fish landings in 1997. Penaeid prawns (41.0%) and nonpenaeid prawns (30.6%) accounted for a major portion of the crustacean fishery followed by stomatopods (18.5%), crabs (9.3%) and lobsters (0.6%). Substantial increase in the landings of crabs (62.0%),

nonpenaeids (47.4%) and stomatopods (28.6%) was recorded in 1997 over the previous year. Moderate increase in the landings of lobsters (9.7%) and penaeid prawns (8.6%) was registered during the year. Trawlers accounted for 93.7% of the landings of stomatopods, 83.8% of penaeid prawns, 81.4% of crabs, 75.7% of lobsters and 47.6% of nonpenaeids. Do/ nets yielded 48.4% of the nonpenaeid prawn production.

ASSESSMENT OF FISHERY AND RESOURCE CHARACTERISTICS OF PENAID SHRIMPS OF THE WEST COAST OF INDIA (CF/RE/1.11)

C. Suseelan, N. Neelakanta Pillai, Mary K. Manissery G. Nandakumar, K.N. Rajan, A.P. Dinesh Babu, V.D. Deshmukh, M. Aravindakshan, V.S. Kakati, K.K. Sukumaran, E.V. Radhakrishnan and K.K. Philipose

The landings along the west coast of India in 1997 stood at 1,55,551 t accounting for 75.4% of the total penaeid landings in the country. The fishery improved by 11.6% over the previous year. Along the west coast, Kerala contributed 36.1% of penaeid prawns followed by Maharashtra (32.0%), Gujarat (23.9%), Karnataka (6.1%) and Goa (1.9%). When compared with the previous year, the fishery improved by 32.1% in Karnataka, 24.6% in Gujarat, and 21.6% in Kerala while it declined by 6.0% in Maharashtra and 8.3% in Goa.

Trawl fishery: Trawlers accounted for 82.5% of the landings along this coast. Statewise contribution of trawlers was 75.8% in Gujarat, 91.2% in Kerala.

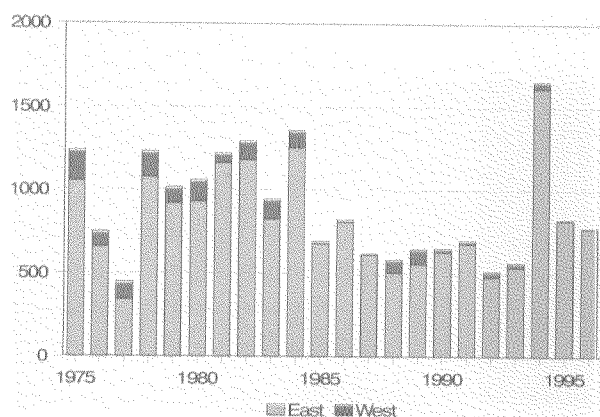
Investigations were carried out on exploited stocks at Veraval, New Ferry Wharf, Bombay, Karwar, Tadri, Malpe, Mangalore, Calicut, Cochin and Sakthikulangara.

Estimated penaeid prawn catches and catch rates (in parenthesis) at important trawling centres of west

coast were 5,818 t (7.2 kg/hr) at Veraval, 19,993 t (11.8 kg/hr) at New Ferry Wharf, 570 t (40.2 kg/boat trip) at Karwar, 620 t (47 kg/boat trip) at Tadri, 1,181 t (0.9 kg/hr) at Mangalore, 884 t (1.5 kg/hr) at Malpe, 1,843 t (43 kg/boat trip) at Calicut, 7,073 t (7.6 kg/hr) at Cochin and 10,556 t (8.6 kg/hr) at Sakthikulangara. Over the previous year, the fishery improved by 33% at Veraval, 40% at New Ferry Wharf, 34% at Malpe, 61% at Calicut and 7% at Cochin while it declined by 5.5% at Mangalore and 19% at Sakthikulangara. At Karwar and Tadri, the landings in 1997 were almost equal to those of the previous year.

Ban on monsoon trawling was imposed for 45 days beginning from the middle of June 1997 along the Kerala coast and for 2 months along the Maharashtra coast.

The landings of *Parapenaeopsis stylifera* during the monsoon period were estimated at 1,416 t and 3,416 t respectively at Cochin and Sakthikulangara. While the fishery improved by 17% at Cochin over the



Landings(t) of *P. monodon* along the east and west coasts of India

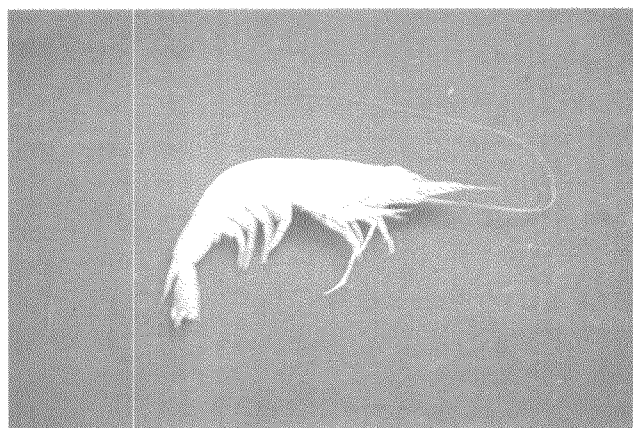
same period of the previous year, landings declined by 39% at Sakthikulangara.

P. stylifera was the dominant constituent along the west coast contributing to 35% of the penaeid landings at Veraval, 45% at New Ferry Wharf, 51% at Karwar and Tadri, 37% at Malpe and 47% at Sakthikulangara. While *Metapenaeus dobsoni* dominated the fishery at Calicut (40%) and Cochin (46%), *Metapenaeus monoceros* (46%) was the principal component at Mangalore. Other important species supporting the penaeid prawn fishery were *Solenocera crassicornis* (34%) and *Parapenaeopsis hardwickii* (13%) at Veraval, *S. crassicornis* (14%) and *Metapenaeus affinis* (14%) at New Ferry Wharf, *M. dobsoni* at Tadri (34%) and Karwar (36%), *M. monoceros* (31%) and *M. dobsoni* (25%) at Malpe, *P. stylifera* (22%) and *M. dobsoni* (14%) at Mangalore, *P. stylifera* (31%) and *Penaeus indicus* (10%) at Calicut, *P. stylifera* (35%) at Cochin and *Trachypenaeus curvirostris* (20%) and *M. dobsoni* (6%) at Sakthikulangara.

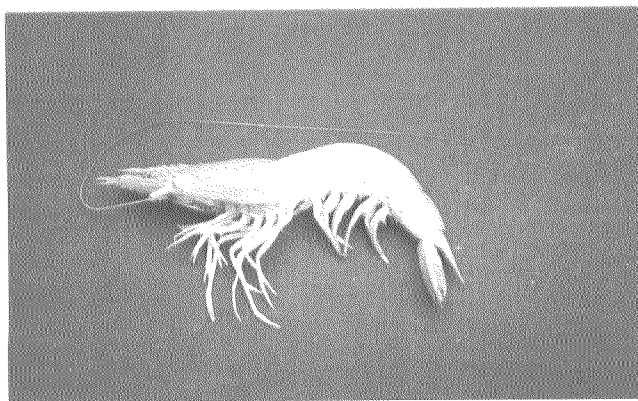
Multiday fishing operations, night trawling and extension of trawling operations into deeper waters have resulted in

the emergence of nonconventional resources such as *Trachypenaeus curvirostris*, *Solenocera* sp. *P. canaliculatus* and *P. semisulcatus* along the coasts of Kerala and Karnataka. Of these species, *T. curvirostris* supported considerable fishery at Mangalore (7%), Cochin (7%) and Sakthikulangara (20%); *Solenocera* sp. accounted for 8% of the landings at Mangalore and 3% at Sakthikulangara. *P. canaliculatus* and *P. semisulcatus* were fished in small quantities at Mangalore, Cochin and Sakthikulangara.

The fishery of *P. stylifera* was dominated by 71-100 mm length range at Veraval, 71-115 mm at New Ferry Wharf, 76-90 mm at Karwar, 76-100 mm at Tadri, 61-95 mm at Mangalore, 71-110 mm at Malpe, 71-95 mm at Calicut, 66-95 mm at Cochin and 76-90 mm at Sakthikulangara. In *M. dobsoni*, bulk of the fishery was supported by 81-105 mm length at Tadri and Karwar, 61-85 mm at Mangalore and Malpe, 76-100 mm at Calicut and 66-90 mm at Cochin. *S. crassicornis* in the length range of 56-95 mm dominated the fishery at Bombay. In *M. monoceros*, 106-155 mm length range formed the mainstay of the fishery at Mangalore and



Metapenaeus dobsoni

*Metapenaeus monoceros*

Malpe. *T. curvirostris* of 61-85 mm dominated the fishery at Sakthikulangara.

Purse seine fishery: Purse seiners operating at Mangalore and Malpe landed 73 t prawns in September 1997. The entire fishery was supported by *M. dobsoni*. No prawn landings were recorded in purse seines in 1996.

Artisanal fishery: Southwest monsoon was the peak fishing season for the artisanal sector in Karnataka and Kerala. At Mangalore, the indigenous gears such as *Matubala* and hand trawls landed 296 t of penaeid prawns in the monsoon months. Fishery declined by 49% over the previous year. Bulk of the fishery (69%) was accounted by *Matubala*. *M. dobsoni* (73%) and *P. stylifera* (25%) were the major components.

In Kerala, the artisanal gears contributed 21.5% to the prawn landings. Mini trawls and ringseines were the major gears for prawns. While ringseines were mainly operated for prawns in monsoon months, mini trawls mainly confined the operations to nonmonsoon period. Intense fishing by these gears was carried out along the Alapuzha coast. These gears together landed 9,896 t of penaeid prawns in Kerala forming 17.6% of the total prawn landings in the state.

The ringseines, disco nets and pair trawls landed

38 t of penaeid prawns at Calicut during July-September. *M. dobsoni* contributed to 90% of the landings, the rest being *P. stylifera*. The fishery in 1997 improved by 166% over the previous year.

At Fort Kochi, ringseines landed 134 t (52 kg/unit) during the monsoon season. The entire fishery was supported by large sized *M. dobsoni* of the length range 81-105 mm.

Prawn landings in *Chakara* (mud bank) at Ambalapuzha in the monsoon period amounted to 1,424 t (85 kg/unit). They showed a 3-fold increase over the previous year. In addition to the ringseines, mini trawls were also employed for fishing operations in August. *M. dobsoni* contributed to 75% of the prawn fishery. Unlike in previous year, *P. stylifera* supported 25% of the catches in Chakara. Though 51-110 mm length classes were represented in fishery of *M. dobsoni*, 71-85 mm sizes were dominant. Spawners were fished in large numbers in July.

Mini trawls at Valanjavazhi (Alapuzha District) fished 1,016 t (36 kg/unit) of prawns in 1997. Catch and catch rate showed increase of 81% and 15% respectively over the previous year. *P. stylifera* dominated the fishery forming 71% of the catch followed by *M. dobsoni* (29%). Operation of this small-meshed gear within 4-7 meters depth results in large scale destruction of juveniles particularly of *P. stylifera*.

Konchu vala (trammel net) operations at Vizhinjam and Mannakudy together netted 141 t (4 kg/unit). Fishery improved by 174% over the previous year. Almost the entire catch was fished between June and August. *P. indicus* (87%) and *P. canaliculatus* (7%) were the major components of the fishery. *P. indicus* of 156-185 mm dominated the fishery with spawners accounting for 49-70% of the landings.

Prawns fishery in the nursery grounds: Stake nets at Korapuzha estuary (Calicut) and Thevara (Cochin backwaters) landed 23 t (11 kg/unit) and 251 t (4 kg/unit) of juvenile prawns respectively. Fishery declined by 79% at Korapuzha and 14% at Thevara

over the previous year. Juveniles of *M. dobsoni* contributed to 82% of the fishery at Korapuzha and 74% at Thevara. In *M. dobsoni* 36-45 mm length classes at Korapuzha and 41-55 mm at Thevara were dominant in the fishery.

ASSESSMENT OF FISHERY AND RESOURCE CHARACTERISTICS OF PENAEID SHRIMPS OF THE EAST COAST OF INDIA (CF/RE/1.12)

G.Sudhakara Rao, M. Rajamani, G. Maheswarudu, V. Thangaraj Subramanian, K.N. Saleela and Shoba Viswanathan

With a total production of 50,479 t in 1997, east coast of India contributed to 24.5% of the penaeid prawn landings of the country; the fishery showed a marginal increase of 0.2% over that of the previous year. Tamil Nadu contributed to 58.5% of the catch along this coast followed by Andhra Pradesh (29.45%), West Bengal (6.0%), Orissa (5.9%) and Pondicherry (0.2%). While Tamil Nadu registered an increase of 7.2% in the landings, the fishery declined by 71.2% in Pondicherry, 1.8% in Andhra Pradesh, 16.6% in Orissa and 20.2% in West Bengal.

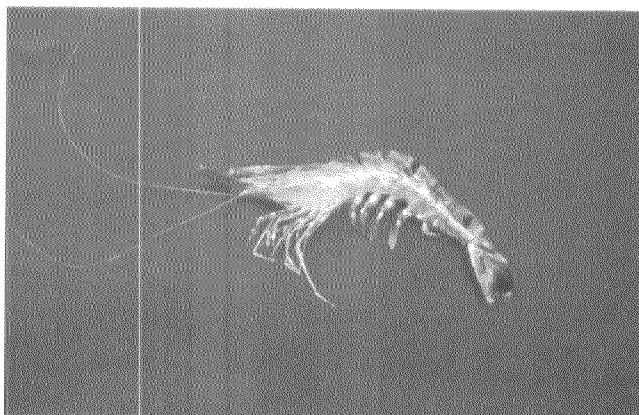
Trawlers landed 83.8% of the penaeid prawn catches along this coast. Statewise contribution of trawlers was 93.9% in TamilNadu, 50.0% in Pondicherry, 79.2% in Andhra Pradesh, 93.1% in Orissa and 74.8% in West Bengal.

Trawl Fishery: Investigations were carried out on the resources exploited by trawlers at Tuticorin, Mandapam, Pamban, Madras, Kakinada, Visakhapatnam and Paradeep.

The catch and catch rate (in parenthesis) at important trawling centres along the east coast in 1997 were 79 t (1.2 kg/hr) at Tuticorin, 755 t (1.5 kg/hr) at Mandapam,

207 t (2.5 kg/hr) at Pamban, 1885 t (2.5 kg/hr) at Madras, 7181 t (7.3 kg/hr) at Kakinada, 325 t (2.0 kg/hr) at Visakhapatnam and 832 t (5.1 kg/hr) at Paradeep. Over the previous year the fishery improved by 14.9% at Kakinada and 0.7% at Visakhapatnam and declined by 38% at Tuticorin, 4.7% at Mandapam 10% at Pamban, 24.6% at Madras and 15.2% at Paradeep.

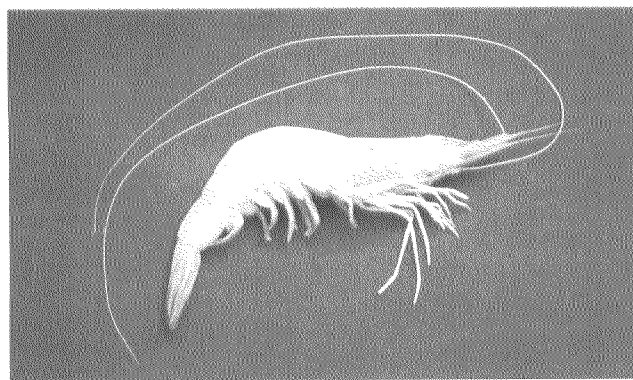
Major components of the penaeid prawn fishery were *Penaeus semisulcatus* (68.5%) and *Parapenaeopsis uncta* (12.9%) at Tuticorin, *P. semisulcatus* (45.7%) and *Metapenaeopsis stridulans*



Penaeus monodon

(37%) at Mandapam, *P. semisulcatus* (44.1%) and *Parapenaeopsis maxillipedo* (38.7%) at Pamban, *Metapenaeus dobsoni* (21.3%) and *Penaeus indicus* (13.2%) at Madras, *M. dobsoni* (34.0%) and *Metapenaeus monoceros* (26.0%) at Kakinada, *M. monoceros* (28.5%) and *M. dobsoni* (21.8%) at Visakhapatnam and *Parapenaeopsis hardwickii* (23.6%) and *M. dobsoni* (17.1%) at Paradeep. Other important constituents in the fishery were *P. maxillipedo* (3.4%) at Tuticorin, *Trachypenaeus pescadorensis* (8.9%) at Mandapam, *P. indicus* (6.4%) at Pamban, *P. maxillipedo* (12.0%), *M. stridulans* (9.6%) and *M. monoceros* (9.1%) at Madras, *Parapenaeopsis* spp. (12.6%) at Kakinada *Metapenaeopsis* spp. (14.2%) and *Solenocera* spp. (12.6%) at Visakhapatnam and *M. affinis* (13.9%), *P. stylifera* (12.3%) and *Metapenaeus lysianassa* (12.0%) at Paradeep.

Smaller species such as *M. stridulans*, *M. maxillipedo*, *M. uncta*, *T. pescadorensis* along the south-east coast and *M. dobsoni*, *M. hardwickii*, *Metapenaeopsis* spp. and *Solenocera* spp. along the northeast coast have gained prominence in the trawl fishery in recent years. These prawns are gradually replacing the large sized prawns such as *M. monoceros*, *P. indicus* and *P. semisulcatus* in the trawl catches along this coast.



Penaeus indicus

Dominant sizes supporting the *P. semisulcatus* fishery were 113-178 mm at Tuticorin, 106-160 mm at Mandapam and 91-150 mm at Pamban. In *M. dobsoni* 61-90 mm sizes at Madras, 61-85 mm at Kakinada and 66-90 mm at Paradeep formed the bulk of the fishery. At Visakhapatnam 116-165 mm sizes were dominant in *M. monoceros* and 131-170 mm in *P. indicus*. Juveniles were dominant in the landings of *M. monoceros* at Kakinada.

Sonaboats operating from Visakhapatnam landed 735 t of penaeid prawns (2.7 kg/hr) registering a decline of 40% over the previous year.

Deepsea prawn fishery at Tuticorin: 863 t (240 kg/boat trip) of deepsea prawns were landed at Tuticorin during the year. Fishery showed a marked improvement of 62% over the previous year. *Plesionika* sp. (50.8%) and *Heterocarpus* spp. (42.5%) dominated the fishery.

Artisanal fishery: At Tuticorin *Thallumadi* operations landed 21 t of prawns at a catch rate of 2.6 kg/unit. Fishery showed a decline of 12.5% over the previous year. *P. semisulcatus* supported 75% of the fishery. 98-133 mm sizes dominated the fishery. At Chinnapalam (Gulf of Mannar) *Thalluvailai* landed 5.8 t of juveniles of *P. semisulcatus* in the size range of 101-115 mm.

Gillnets and *Disconets* at Puri realised a catch of 102 t (4.2 kg/unit). Prawn fishery in the traditional sector improved by 73% over the previous year. *P. indicus* (88%) dominated the fishery followed by *M. affinis* (8%).

Fishery in the nursery grounds: Stake nets at B. V. Palem (Kakinada) fished 165 t (12 kg/unit) of juvenile prawns dominated by *M. monoceros* (61%) and *M. dobsoni*

(11%). Catch and catch rate declined by 39% and 50% respectively over the previous year.

A review of the *P. monodon* fishery

Analysis of the data on *P. monodon* for the years 1975-96 indicated 3 phases in the history of the fishery. The first 10 year period of 1975-84 was a period of maximum abundance with average annual landings of 1055 t. The second phase was during 1985-93 when the fishery indicated drastic decline in the landings with average annual landings estimated at 641 t. The third phase was during 1994-96 when the landings were very heavy in all the three years. The very heavy landing of 1994 were mainly due to the overflowing of prawn farms along the Andhra coast and the escape-ment of the stock into the sea. This extraordinary recruitment had helped in maintaining higher levels of abundance in 1995 and 1996.

The MSY of *P. monodon* was estimated as 652 t based on the data of 1985-88. A perusal of the data for the period 1985-93 suggests that whenever the landings exceeded the MSY level, the fishery was poor in the succeeding years and revived once again indicating resilience capacity of the stock.

A detailed analysis of the catch and effort data of *P. monodon* from small trawlers at Visakhapatnam and Kakinada showed that the stock is more or less maintaining at the same level during 1991-92 to 1996-97 with annual fluctuations. Hence it can be said that there is no threat of declining abundance of the species in the sea. Size composition of females at Kakinada showed a decline in the proportion of adults (above 200 mm total length) from 35% in 1992-93 to 18.3% in 1994-95 and increased thereafter to 22% in 1995-96 and 34.7% in 1996-97 indicating the occurrence of considerable adult population in the stock.

INVESTIGATIONS ON THE NONPENAEID SHRIMP FISHERY OF NORTHWEST COAST OF INDIA (CF/RE/1.13)

V. D. Deshmukh and A. P. Dineshbabu

The estimated nonpenaeid prawn production of India amounted to 1,53,959 t. Gujarat (56.24%) and Maharashtra (38.67%) were the two maritime states which contributed to the bulk of this resource. In comparison to the previous year the landings of nonpenaeids improved in 1997 by 28.4% and 111% in Gujarat and Maharashtra respectively. Shrimp trawls and dol nets were the main gears used for exploitation of this resource in these two states. Trawlers accounted for 77.7% of the nonpenaeid prawn landings in Gujarat whereas in Maharashtra the dol nets contributed to 95% of the catch.

Trawl fishery: The nonpenaeid prawn catch at Veraval in Gujarat amounted to 38,378 t (387.5 kg/unit) which formed 34.7% of the trawl landings. The

catch showed about two fold increase over 1996. The catch was mostly contributed by *Acetes* spp. (97.7%) followed by *Nematopalaemon tenuipes* (1.9%), *Exopalaemon ensirostris* (0.2%) and *E. styliferus* (0.07%).

The catch at New Ferry Wharf and Versova during 1997 was estimated as 898 t and 646 t respectively. The catch rates were 28.4 kg and 41.6 kg per unit respectively. While the catch at New Ferry Wharf declined by 43.5% it showed a marginal increase over the previous year at Versova. At both the centres the entire nonpenaeid prawn catch comprised *N. tenuipes* only.

Dol net fishery: The estimated catch of nonpenaeid

prawns at Nawabundar and Rajpara in Gujarat was 4489 t (22 kg/unit) and 4621 t (18.1 kg/unit) respectively which showed increase of 147% in the former centre and 81% in the latter in comparison with previous year's landings. *Acetes* spp. dominated the catch in both these centres (67-71%) and the other species were *N. tenuipes*, *E. ensirostris* and *E. styliferus* in the order of abundance. Occurrence of *E. styliferus* was noticed mainly during October-November.

N. tenuipes of 41-52 mm and *E. ensirostris* of 71-85 mm length range dominated the dol net fishery. The peak spawning month was October for *N. tenuipes* and June for *E. ensirostris*.

At Versova and New Ferry Wharf dol/nets landed 2,356 t (301.8 kg/unit) and 119.3 t (58.2 kg/unit) of nonpenaeid prawns respectively. The fishery improved marginally at both these centres showing 8.7% increase

at Versova and 5.6% at New Ferry Wharf. *Acetes* spp. dominated the dol net landings in these centres forming between 82-86% of the nonpenaeid catch and the rest being shared by *N. tenuipes* and *E. ensirostris*.

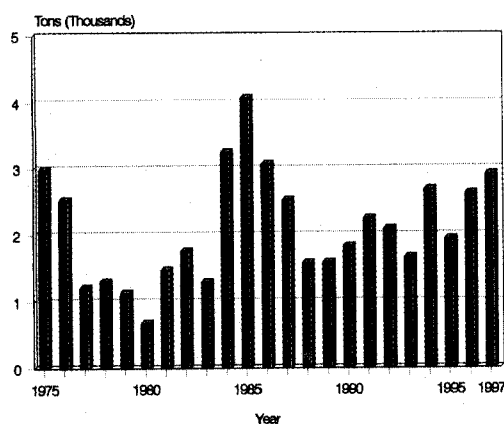
A. johni dominated the catch at Versova during October-November while *A. sibogae* dominated at New Ferry Wharf during December-February period. *A. indicus* dominated the catch at these centres during the remaining period of the year. At Versova, *N. tenuipes* of 48-54 mm TL was dominant in the 'dol' nets while 51-54 mm size group dominated the trawl landings. April-May and July-August were found to be peak spawning periods for *N. tenuipes* in the Mumbai region. The dominant size of *E. ensirostris* in the catch was 71-85 mm and the peak spawning periods were December-January and May.

STUDIES ON LOBSTER AND CRAB RESOURCES OF INDIAN COAST (CF/RE/1.14)

Mary K. Manisseri, Joe K. Kizhakudan, V.D. Deshmukh, V.S. Kakati, K.K. Sukumaran, E.V. Radhakrishnan, K.K. Philipose, D.B. James, Josileen Jose, V. Thangaraj Subramanian and K.N. Saleela

LOBSTER

The total estimated landing of lobster during 1997 was 2,917 t which showed an increase of 286 t over the



Lobster landings in India

previous year. Maximum landing was recorded in Gujarat (48.17%) followed by Maharashtra (28.04%). The landing was only 375 t in Tamil Nadu, 265 t in

Kerala and 47 t in Karnataka. Gujarat showed an increase of 275 t over the previous year whereas Maharashtra showed a decrease of 314 t. A marginal improvement of the fishery was observed in Tamil Nadu, Kerala and Karnataka. Mechanised trawlers, landing about 2,208 t, accounted for 76% of the total catch of lobsters. A regionwise study of the data shows that the northwest region accounted for 76.2% of the catch, southwest region contributing 10.7%, southeast region 12.9% and northeast region 0.2%. A quarterwise

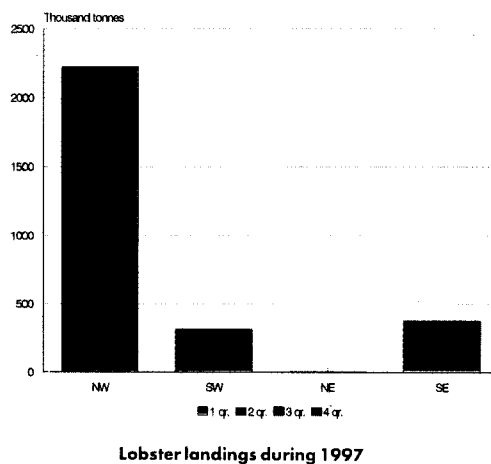
analysis of the data showed maximum landing in the first quarter of the year (1220t) followed by the fourth quarter (1080t), second quarter (447 t) and third quarter (170t).

Investigations were carried out on the fishery and biology of lobster at Veraval, Bombay, Calicut, Vizhinjam, Tuticorin, and Madras. The major gear operated for the exploitation of lobster fishery was trawl net. However, artisanal gears such as bottom set gillnet and traps were also in use at Tuticorin and Vizhinjam.

At Veraval, the fishery was constituted by *Panulirus polyphagus* and *Thenus orientalis*, distributed more or less equally. The percentage composition of female lobster was generally higher. Berried females were also landed in good numbers. Landing of juvenile *P. polyphagus* weighing about 100 g or less and fetching rather poor market value was recorded in the month of December. The lobster fishery in Bombay was constituted by *P. polyphagus*. The fishery for the sand lobster *T. orientalis* continued to be poor in this region. At Calicut the lobster fishery was predominated by *Panulirus homarus*. *P. ornatus*, *P. polyphagus* and *P. versicolor* also contributed to the fishery. Bottom set gillnets were used for lobsters in this region. In *P. homarus*, the modal sizes of both males and females ranged from 61 mm to 70 mm (CL). In December 16% of the females were in berried stage. Studies were carried out on the landing of lobster using traps, at Vizhinjam and Muttom along the southwest coast. The trap fishery is highly seasonal and usually extends from September to May. *P. homarus* predominated the landings at both the Centres. At Vizhinjam about 3700 units landed 1.3 t of lobster. This formed nearly 70% of the trap catches. Maximum catch was recorded in October. The dominant modes of males and females were at 56-60 mm (CL) and 61-65 mm (CL) respectively. Female lobsters predominated the catches. Berried females formed

about 19% of the female population. Landing at Muttom by traps was over 4 t with a CPUE of 0.9 kg.

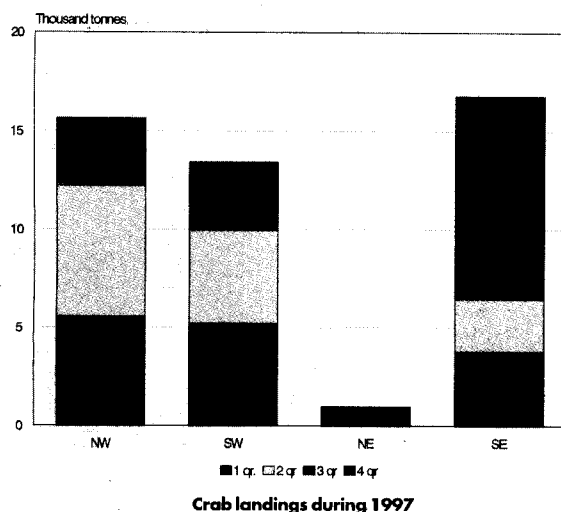
At Tuticorin, both trawl net and bottom set gillnet were used for lobsters. The landing by trawl net was 10.6 t with a CPUE of 0.4 kg. *P. ornatus* predominated the fishery (72.5%) followed by *P. homarus*. In *P. ornatus*, the sizes ranged from 187 to 291 mm in males and from 170 to 370 mm in females. Sexes were more or less equally distributed. Maximum landing was recorded in the month of February. The total landing of lobsters using bottomset gillnet was 7.7 t with a CPUE of 1.6 kg at Kayalpattanam and 6.1 t with a CPUE of 1.0 kg at Tharuvaikulam. *P. ornatus* predominated the fishery as in the case of trawl fishery. Sporadic occurrence of *P. penicillatus* and *P. versicolor* also was noticed. The percentage of berried female *P. homarus* rose to 33.3 in the month of February. Smaller size groups were landed as a result of fishing in shallower grounds of about 2-3 m depth. Operation at a depth of 300 m resumed during the first quarter of the year. A total of 56 t of *Puerulus sewelli* was landed by 1950 units at a CPIUE of 29 kg. At Madras, the lobster fishery was dominated by the sand lobster, *T. orientalis*. Stray occurrence of *P. homarus* was also observed. The prices of lobster depended on the size and ranged from Rs. 50 to Rs. 1250 per kg.



CRAB

With a total production of 46,958 t, the crab fishery registered an improvement over the previous year when the landing was only 29,049 t. Maximum landing was recorded in Gujarat (30.1%) followed by Tamilnadu (28.5%) and Kerala (22.2%). Andhra Pradesh, Karnataka and Maharashtra landed only 6.5%, 4.9% and 3.2% respectively. In Gujarat the fishery improved from 9,605 t in 1996 to 14,148 t in 1997, in Kerala from 3,581 t to 10,438 t and in Tamilnadu from 9,681 t to 13,394 t. Maximum landing was recorded by trawl though indigenous gears were also used. The trawl landing was 38,217 t which accounted for 81.6% of the total catch. A study of the regionwise production showed that the southeast region contributed to 35.8% of the fishery, northwest region 33.4%, southwest region 28.7% and northeast region 2.1%. Catch was maximum in the 1st quarter (14,873 t) followed by the 2nd quarter (14,247 t) and 4th quarter (12,961 t). Landing was only 4,736 t in the 3rd quarter.

Charybdis lucifera predominated the catches at Veraval contributing to over 90% of the total landing. However, the crabs were landed in rotten condition and were used exclusively for fish meal production. At Bombay, *C. cruciata* predominated the fishery of crabs,



followed by *Portunus sanguinolentus* and *P. pelagicus*. The percentage of berried females in *C. cruciata* rose to 76% in the month of September. At Karwar, the fishery was predominated by *P. pelagicus*. *P. sanguinolentus* was landed in very small quantities. *C. feriatus*, *P. sanguinolentus* and *P. pelagicus* contributed to the fishery at Mangalore. Berried females of *P. sanguinolentus* were more in March, April and October. At Calicut a total of 411 t of crab were landed with a CPUE of 9.6 kg by trawlers. Maximum landing was recorded in May 1997. The fishery was seasonal, recording good landings from January to June. *C. cruciata* predominated the catches followed by *P. pelagicus* and *P. sanguinolentus*. Sizes of *C. cruciata* ranged from 41 to 85 mm in males and from 36 to 80 mm in females. At Cochin the fishery was predominated by *P. sanguinolentus* followed by *C. cruciata* and *P. pelagicus*. The monthly CPUE ranged from 0.6 kg to 6.4 kg with an average of 3.0 kg. Berried females were present in good numbers in May 1997. Females predominated in all the species. The season lasted from January to May.

The total landing of crab by *Konchuvula* units at Vizhinjam during the year was 63 t, with a CPUE of 3.0 kg. Maximum landing was recorded in August 97. The fishery was constituted by *P. pelagicus*, *P. sanguinolentus*, *C. lucifera* and *C. cruciata*.

The crab fishery at Tuticorin also was predominated by *P. pelagicus*. *P. sanguinolentus*, *Scylla serrata*, *S. tranquebarica* and *C. natator* also contributed to the fishery. The total landing at Tharuvaikulam during the year was 25.4 t with a CPUE of 5.28 kg. Maximum landing was recorded in the month of July 1997. Berried *P. pelagicus* were present in the catches in all the months, with a peak in May. Both trawl and, gillnets (*Nanduvalai*) were employed at Mandapam for landing edible crabs.

Trawlers landed only *P. pelagicus* and this amounted to more than 75% of the total landing. The traditional gear landed *P. pelagicus* and small quantities of *Scylla serrata* (males ranging in size from 113.3-146.0 mm and females from 107.0-170.0 mm).

The Fishery for crab at Madras was exceptionally good during the last quarter of the year. Maximum catch was recorded in December 1997 (445 t). *P. sanguinolentus* predominated the catches, followed by *C.*

natator, *P. pelagicus* and *C. cruciata*. *C. lucifera* occurred in small numbers during October-November. Females predominated the fishery of *P. sanguinolentus*. Immature females were more in October while berried females were in good numbers in November-December. At Kakinada also, *P. sanguinolentus* predominated the fishery for crabs, followed by *P. pelagicus*, *C. cruciata* and *C. lucifera*. Female *P. sanguinolentus* were observed in all stages of maturity. However, immature females predominated the catches.

DEVELOPMENT OF ARTIFICIAL REEFS (CF/RE/3)

M. Rajamani and K.K. Philipose

An artificial reef with 49 modules covering an area of 1000 sq m was installed on 1.6.1997 at a depth of 6 m off Vellapatti near Tuticorin. Local fishermen were actively engaged in this operation. Fishing with drift gillnet yielded 54 kg of finfish and 5.4 kg of lobsters in October '97. Finfish catch composed of sharks, rays, perches and soles. The proportion of lobsters in the reef catches was much higher (9.1%) than in the non reef region (1%). The lobster catch of the reef consisted of *P. homarus* (80%) and *Panulirus ornatus* (20%). Crabs were also taken in the reef landings.

The behaviour studies conducted with hideouts made of clay pipes, PVC pipes and cement rings showed that *P. homarus* and *Charybdis natator* have high degree of attraction towards reef structures while

the finfish *Therapon jarbua* and *Siganus* sp. and the swimming crab *Portunus pelagicus* were not attracted.

Two artificial reefs, one for finfish and the other for lobsters were installed in March 1997 off Vizhinjam with the involvement of local fishermen. The finfish reef with 35 modules covering an area of 500 sq.m and the lobster reef with 40 modules covering 600 sq.m. were installed at depths of 20-25 m and 10 m respectively. Although the reef matured in September fishing was conducted only in November and December. An estimated Rs.2.25 lakhs was realised from the catch of these reefs in the two months period.

A policy paper was submitted to the Government of India on the optimum number of artificial reefs to be established in each maritime state.

SEED PRODUCTION, EXPERIMENTAL FARMING AND TAGGING OF MARINE PRAWNS (CF/CUL/1.9)

N. Neelakanta Pillai, M. Peer Mohamed, A. Laxminarayana, G. Nandakumar, K.N. Rajan, N. Sridhar, Manpal Sridhar, N.K. Sanil, P.E. Sampson Manickam, Molly Varghese, Miriam Paul, V.S. Kakati, E.V. Radhakrishnan, G. Maheswarudu, Josileen Jose, N. Kaliaperumal, G. Rathore and P.T. Sarada

Thirteen experiments were carried out on the seed production of *Penaeus semisulcatus*. Spawners rang-

ing from 138-191 mm in total length and 18-70 g in weight collected from trawl catches were brought to the

laboratory for spawning. Hatching rate from egg to nauplii was 68.8%, nauplii were reared in larval rearing tanks of 5 t capacity. Different stocking densities from 22 no./L to 66 no./L were tried. A maximum of 72.8% survival was obtained at a stocking rate of 66 no./L. Post larvae were fed with prawn meat egg custard (1-1.5 mg/larvae/day), pellet diet (1-1.5 mg/larva/day) and *Artemia* nauplii (2-4/larvae/day). *Artemia* nauplii were given upto PL 8 only. A total of 5.1 lakh post larvae were produced, of which 4.6 lakh have been used for sea ranching experiments and 51000 PL20 for carrying out farming experiments in the departmental ponds.

Nine experiments on the farming of *P. semisulcatus* were carried out using laboratory reared postlarvae. Three ponds each of 0.25 ha area at Mandapam were prepared and stocked with postlarvae of 0.02 g wt and 10.37 mm total length at a stocking rate of 60,000/ha. They were reared for a period of 135 days using feed of C.P. Aquaculture Private Ltd. During this period, males grew to 11-15 g weight and 114-122 mm total length. Females reached 16-21 g and 124-134 mm.

Second series of experiments were carried out in 6 earthen ponds. Ponds with 2500 m² water spread were stocked with seed of *P. semisulcatus* (8-14 mm TL and 0.006-0.028 g of weight) at a stocking density of 5-6/m². Ponds with 800 m² water spread were stocked with seed of 15 mm TL and 0.03 g weight at a stocking density of 3-3.75/m². Water level was maintained at 0.9m and pellet diet (C.P. Aquaculture Private Ltd.) was used to feed the stock. After 45 days, an average growth rate of 1.1-1.6 mm/day in TL and 0.06-0.137 g in weight was observed. Experiments are being continued.

Regular experiments were carried out for developing a viable technology for the mass production and maintenance of live feed organisms for crustacean larvae. In this connection, a series of experiments was carried out on *Brachionus rotundiformis* and *Moina*

micrura and some marine cyclopoid and harpacticoid copepods.

Preliminary experiments were carried out on the rearing of *B. rotundiformis* (marine 30-32 ppt salinity) purely on the diatom *Isochrysis* sp. At a stocking rate of 57 nos/ml, a 2.9 fold increase was observed in 5 days when the rotifer concentration reached 167 no./ml. The concentration of *Isochrysis* in the medium was maintained between 1.3-1.5 lakhs cells/ml. The concentration of *Isochrysis* in the medium was increased to 2.1-3.0 lakh cells/ml and the experiment was continued for three more days. On 8th day, 3.5 fold increase was obtained and the concentration of rotifer in the medium reached 204 nos/ml. Although the experiment was continued for 16 days under the same feeding schedule, no further increase in the concentration was observed. Preliminary experiments thus indicate, that when *Isochrysis* is used as feed and the concentration of the same is maintained between 1.3-1.5 lakh/ml, it is advantageous to harvest 2/3rd of the animals after 5 days. After the concentration reaches 167 no./ml, regular harvesting of 2/3rd animals every third day is recommended. The size of the animal is 110-180 micron.

Experiments were carried out in *Moina micrura* to study its reproductive potential under controlled conditions. Freshwater *Chlorella* spp. was used to feed the experimental animals. It was observed that during the first 10 days the newborn parthenogenetic female moulted 9 times. After second moult, an average of 7 parthenogenetic females were produced. During the first 10 days, the average number of young ones produced from one female was 57. Based on these observations, the number of parthenogenetic females which could be obtained from a single female in 10 days was calculated as 23,258. The size of the animal varied from 530 to 700 micron.

Analysis of proximate composition of *Moina micrura* was carried out. Protein content of 49% and a

moderate lipid content of 18% was observed.

Regular observations were made on the abundance of decapod larvae in the Minicoy lagoon. A total of 18346 decapod larvae were collected during this period. Maximum abundance of larvae was observed during October-December months and minimum during June and July. Postlarvae of *Penaeus latisulcatus* and *P. canaliculatus* (average size 15mm) collected from the lagoon were reared under controlled condition. Initially, they have registered a growth of 12-15 mm/month.

As a part of the objectives of the project, consultancy services were rendered to 1) the Tata Chemicals Ltd., Mithapur, Okhamandal, Gujarat State, 2) the Ebi Culture India Ltd. Shrimp Hatchery, Alibag, Maharashtra State, 3) the Bada Pokharan Hatchery,

Maharashtra State and 4) The Asangaon Brackishwater/ Mariculture farm, Maharashtra State to improve hatchery facilities for induced maturation as well as to enhance the seed production capabilities. By implementing the recommendations, the Ebi Culture India Ltd Shrimp hatchery at Alibag had succeeded in the induced maturation of *P. monodon* under controlled conditions and also succeeded for the first time in producing the postlarvae on commercial scale, with 70% survival.

Practical training on various aspects of shrimp hatchery for M.F.Sc. students was imparted at Mandapam Camp.

A 12-day training programme "On hatchery production of shrimp seed" was conducted at Mandapam Camp for 5 trainees from different organisations.

BROODSTOCK DEVELOPMENT, SEED PRODUCTION, FARMING AND SEARANCHING OF COMMERCIALY IMPORTANT SPINY AND SAND LOBSTERS (CF/CUL/1.10)

E.V. Radhakrishnan, M.Rajamani, S. Lakshmi Pillai, K.K.Philippose and Joe K. Kizhakudan

With a view to develop a suitable indigenous technology for the broodstock maintenance, hatchery and farming of commercially important lobsters of India, experiments were conducted at Veraval, Calicut, Vizhinjam and Tuticorin.

At Veraval, a berried spiny lobster, *Panulirus polyphagus* of 10.7 cm CL and 600 g weight was collected and transported to the laboratory. The colour of the berry was deep orange. Lobster was maintained in quality seawater, under controlled conditions in a one ton capacity pool. Biofilter and artificial shelters provided. Lobster was fed *adlibitum* with gastropod meat. After 14 days, the eggs were fully developed and hatched out to phyllosoma/naupliosoma and the hatching continued to next day also. Few healthy

phyllosoma larvae were collected and transferred to smaller containers of 250 ml - 15 litre capacity, for closer observation. A minimum of 100% water exchange was provided. Larvae were fed with freshly hatched *Artemia* nauplii which they have accepted readily. Survival of phyllosoma larvae was encouraging during the first ten days. Afterwards heavy mortality was observed due to ciliate infection.

At Calicut, experiment on the rearing of *phyllosoma* larvae of *P. homarus* was initiated. Larvae were reared in glass troughs containing sterilized seawater. The stocking density was 10 no/l. Water was changed partially. The larvae were fed mussel meat from stage 3 onwards, in addition to freshly hatched *Artemia nauplii*. Good survival was obtained until stage 4. During

these experiments, larvae reached the 6th stage in 50 days whereas in the earlier experiments, larvae took 60 days to develop to 6th stage.

At Vizhinjam, experiments were initiated on the growout operations of *P. homarus*, 650 numbers of juveniles weighing 25-100 g were stocked and fed with mussel meat. A growth rate of 35-40 g per month is reported under good water quality and feed conditions.

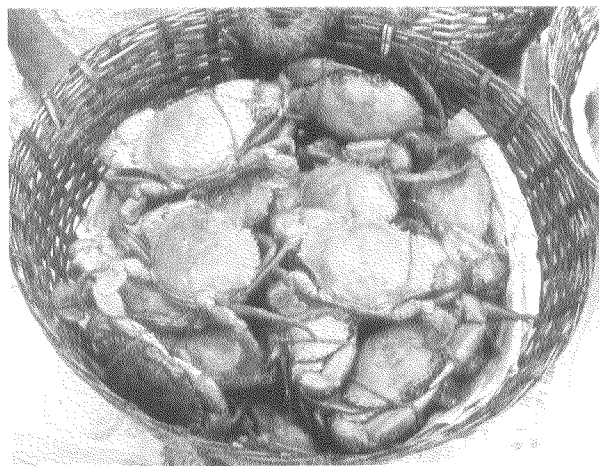
At Tuticorin, attempts were made to develop a broodstock of *P. homarus*. Adult males and females in the size of 209-240 mm total length were maintained in FRP tanks and fed clam meat daily.

Juveniles of *P. homarus* and *P. ornatus* stocked in FRP tanks showed a growth rate ranging from 0.113 g/day to 0.252 g/day in the former and 0.155 g/day to 0.288g/day in the latter.

MARICULTURE OF CRAB (CF/CUL/1.11)

G.Sudhakara Rao, M.Peer Mohamed, C.Suseelan, A. Laxminarayana, N. Sridhar, Manpal Sridhar, N.K. Sanil, P.E.Sampson Manickam, Molly Varghese, Miriam Paul, S.Lakshmi Pillai, G. Maheswarudu, Josileen Jose, N. Kaliaperumal and G. Rathore

As a step towards the propagation of crab farming, 10 farmers at Chellanam were selected to give technical advise on crab farming. These farms varying from 2 - 4.1 cents in extent were stocked with 120 - 140 numbers of crabs of 150 - 250 g weight in September 1997. After 3.5 months a production of 110 kg was realised on an average, for a farm of 3 cents. At harvest the crabs ranged in weight from 550 - 850 g. During the culture period the salinity varied from 1.7 - 7.2 ppt and the pH 7.5-8.0.



Crabs harvested at Tuticorin

At the Fisheries Harbour Laboratory, Cochin experiments in broodstock development were carried out. Although crabs are mating and the females are developing the berry, on many instances the eggs are shed prematurely resulting in the failure of hatching. A berried crab caught from Cochin backwaters yielded 50,000 zoea which died on the 6th day of hatching.

Proximate analysis of crab meat was made with a view to arrive at the nutritional requirements of crabs and thereby formulate diets based on these analyses.

Attempts are being made to formulate feeds with locally available ingredients.

A training programme on crab farming and mangrove cultivation was organised during 4.7.97 to 12.7.97 for the three-member Maldivian team.

At Tuticorin, *S. tranquebarica* spawned in the laboratory in three instances. The crab spawned on 14.7.97 gave 14.1 lakh zoea. They survived only for four days in *Isochrisis* and *Tetraselmis* cultures. In the second experiment, a crab gave 15.7 lakh larvae which survived for

4 days in *Isochrysis* and *Chlorella* cultures. In the third experiment a male of 550 g and female of 450 g mated and the female got berried after 3.5 months. It spawned after ten days giving 7.7 lakh zoea. These larvae, reared in a mixed culture of *Chlorella* and rotifer cultures survived for seven days.

At Mandapam F1 and F2 generations of *P. pelagicus* obtained in 1996-97 from wild mother were reared to produce F3 generation in 1997-98. The F2 generation males and females produced in January 1997 had grown to 40 g and 50 g respectively in 126 days. Although F2 generation females started spawning after 173 days, the zoea did not reach the baby crab stage in the 10 spawnings occurred during the reporting period. However one female of F2 genera-

tion spawned on 28.10.97 producing 2.5 lakhs of viable zoea. About 200 baby crabs were obtained from these zoea. The same female spawned on 21.11.97 giving 2.3 lakh of viable zoea which are being reared.

During the year *P. pelagicus* females collected from wild, spawned on 35 occasions in the hatchery. However baby crabs could be produced only from two spawnings. Failure of aeration resulted in the mortality in all the other experiments.

5 females of *S. tranquebarica* of 350-420 g and 3 males of 400-1200 g were stocked in October to study the maturation process. At the end of December 1997 the females increased in weight by 17-45%.

INTENSIVE CULTURE OF BRINE SHRIMP (CF/CUL/1.12)

M. Rajamani and S. Lakshmi Pillai

Experiments were carried out to develop a viable technology for the biomass/cyst production of Brine shrimp under controlled conditions. An exotic species of Brine shrimp *Artemia franciscana* was collected from the salt pans of Tuticorin and was maintained in outdoor tanks and successive generations were obtained. Using these animals, further studies on its various biological aspects had been carried out.

Males and females of *A. franciscana* attained maturity under controlled conditions when they attained a size of 6.62 and 7.02 mm respectively. Mating was observed when they were of six days old and spawned on 10th day. At first spawning 15 nauplii were released. The average size of nauplii was 0.485 mm. They attained 4.21 mm length in 11 days and 6.8 mm in 15 days with growth rate increasing from 0.377 mm/day on 1st day to 0.647 mm on 15th day.

Experiments were also carried out in one ton capacity cement tanks to study the production of biomass and cysts of *A. franciscana* under controlled conditions. 10 pairs of this species were released into the rearing tanks. In 12 days a biomass of 40 numbers/litre was obtained which became 74 numbers/litre in 18th day. It was also observed that biomass production was found to be higher when the animals were fed with *Isochrysis* instead of *Tetraselmis* sp.

Besides, a survey of the natural population of *Artemia* in three different stations, Vepalodai, Arumuganeri and Alankarathattu - were initiated to study the distribution of the two different strains of *Artemia* - *A. franciscana* and *A. parthenogenetica*.

V. MOLLUSCAN FISHERIES DIVISION

INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF CEPHALOPODS
(MF/RE/1)

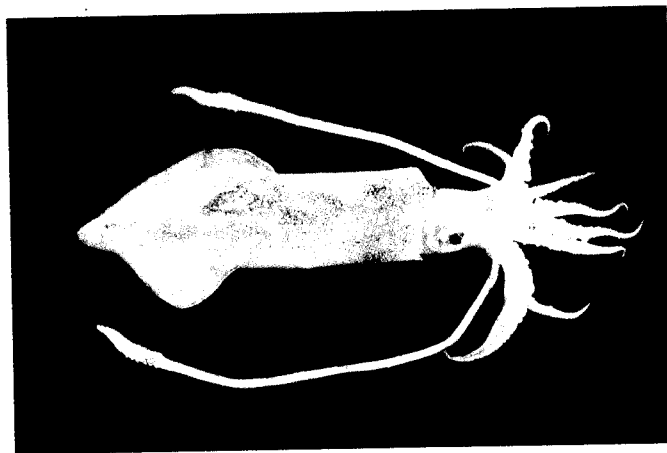
M.M. Meiyappan, Sujitha Thomas, Kuber Vidyasagar, V. Kripa, K.S. Mohamed,
K. Prabhakaran Nair, R. Sarvesan, E.M. Abdusamad, G. Syda Rao,
Shoji Joseph and Geeta Sasikumar

Fishery

The total cephalopod production during the year was estimated at 1.16 lakh t. Trawl was the chief gear exploiting this resource at all centres except Vizhinjam where hooks & lines and boatseines landed this resource. Significantly high catch rate of 400 kg was obtained off Bombay and 150 kg off Mangalore.

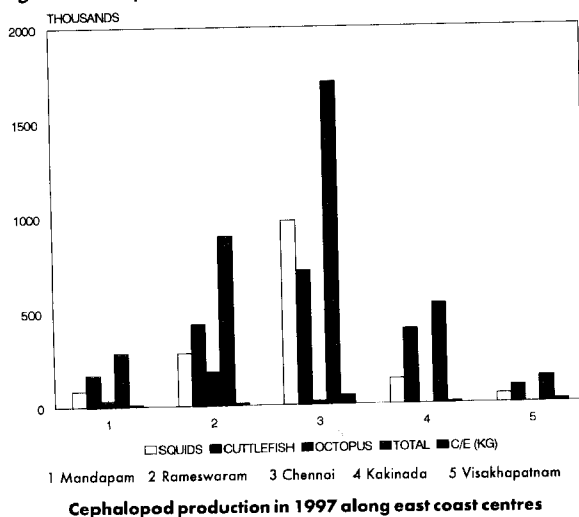
Squids constituted the dominant component at Veraval, Mangrol, Karwar, Tadri, Mangalore, Malpe, Vizhinjam and Madras and cuttlefishes at the other centres. *Octopus* landings were recorded only at Mandapam, Rameswaram and Madras.

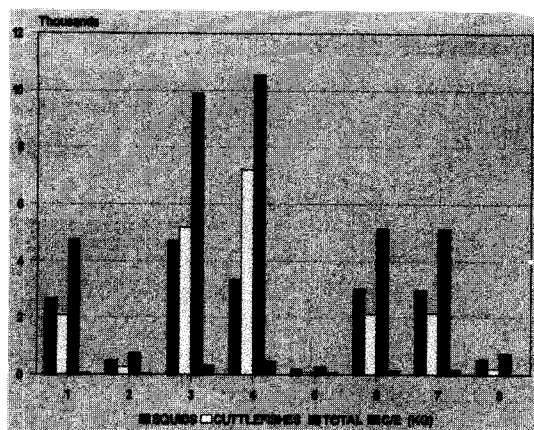
Among squids, *Loligo duvauceli*, *L. uyii*, *Doryteuthis sibogae* and *Sepioteuthis lessoniana* contributed to the

*Loligo duvauceli*

fishery, but *L. duvauceli* was the sole component at all the centres except Mandapam, Rameswaram, Madras and Kakinada. At Mandapam and Rameswaram two species formed the fishery: *D. sibogae* was the most dominant followed by *L. duvauceli*. At Madras and Kakinada *L. uyii* also occurred in the catches besides the above two species.

Among cuttlefish, *Sepia pharaonis* and *S. aculeata* dominated the landings along both the coasts. *S. elliptica* was landed in good quantities at Veraval and Mangrol. At Madras and Kakinada, *S. brevimana* was also caught in moderate quantities. *S. prashadi* appeared occasionally at Madras but was landed in significant quantities at Mangalore and Malpe.





1 Veraval 2 Mangrol 3 Mumbai NFW 4 Mumbai SD 5 Tadri 6 M'lore 7 Malpe 8 Vizhinjam

Cephalopod Production in 1997 along west coast centres

At Madras, the *Octopus* catch was composed of *Ocotopus dofus* and *Cistopus indicus*. *Octopus dofleni* was reported for the first time from India (from Rameswaram) in January 1997 in shoreseine catch. This species is common in the North Pacific and is called as the North Pacific Giant *Octopus*.



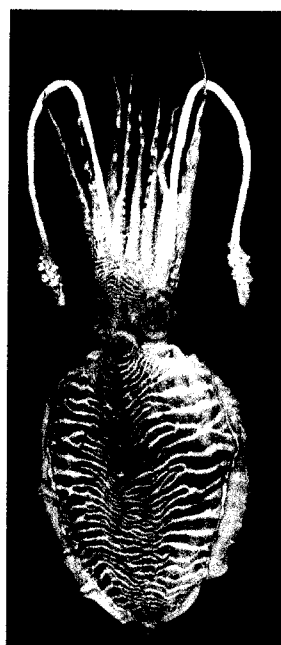
Octopus membranaceus

Biology

***Loligo duvauceli*:** The length range in the catch was 20-300 mm at different Centres. Large-sized squids were caught at Gujarat and Maharashtra Centres but the maximum length was around 150 mm along Tamil Nadu and Andhra Pradesh. Juve-

niles occurred during January-April at Veraval, Bombay, Kakinada, and during October-December at Mangalore. Mature squids were observed throughout the year in all centres. Mature females were dominant during April, May and December at Veraval; January-March at Mangalore; May, September and February at Madras.

***Sepia aculeata*:** The dorsal mantle length varied between 30 and 220 mm at different Centres. Mature adults of both sexes were observed in all months with dominance during October-December along Veraval coast.



Sepia pharaonis

***Sepia pharaonis*:** The length range in the catch was 70-310 mm at Bombay, Madras, Kakinada and Visakhapatnam.

***Doryteuthis sibogae*:** The DML of this squid ranged between 60 and 190 mm along Madras coast.

Estimated landings of cephalopods by trawl at different centres

Centre	Cephalopod Catch (t)	C/E (kg)	% in AF	Squids (t)	Cuttle fish (t)	Ocotopus (t)
Veraval	4751	51	5	2670	2081	0
Mangrol	759	41	6	496	263	0
Bombay NFW	9906	321	15	4721	5185	0
Bombay SD	10556	470	14	3358	7198	0
Karwar	6	1	0.3	6	0	0
Tadri	279	72	19	199	80	0
Mangalore	5154	134	16	3034	2120	0
Malpe	5126	171	15	2975	2150	0
Vizhinjam	*743	13	8	542	201	0
Mandapam	283	9	4	85	167	31
Rameswaram	896	12	3	281	434	181
Madras	1709	50	8	977	712	20
Kakinada	532	10	2	134	398	0
Visakhapatnam	139	15	6	48	91	0

C/E : Kg per trawler day AF : All fish * Boatseine

Estimated species composition (weight kg) of cephalopods at different centres

Centre	LD	SL	DS	LU	SP	SA	SE	SB	SPR	SI
Veraval	2670	0	0	0	576	808	580	0	0	117
Mangrol	496	0	0	0	19	127	99	0	0	18
Bombay NFW	4721	0	0	0	1772	3197	0	0	0	217
Bombay SD	3358	0	0	0	4354	2717	0	0	0	128
Karwar	6	0	0	0	0	0	0	0	0	0
Tadri	199	0	0	0	80	0	0	0	0	0
Mangalore	3034	0	0	0	494	1359	0	0	99	168
Malpe	2975	0	0	0	483	1390	0	0	70	207
Vizhinjam	534	0	9	0	201	0	0	0	0	0
Mandapam	22	63	0	0	87	59	0	0	0	21
Rameswaram	85	196	0	0	200	186	0	0	0	49
Madras	596	0	319	43	406	225	0	23	6	58
Kakinada	111	0	9	12	102	88	0	16	0	192
Visakhapatnam	48	0	0	0	27	31	0	0	0	7

LD: *L. duvauceli*; DS: *D. sibogae*; LU: *L. uyii*; SP: *S. pharaonis*; SA: *S. aculeata*; SE: *S. elliptica*; SI: *S. inermis*; SPR: *S. prashadi*; SL: *Sepioteuthis lessoniana*

INVESTIGATIONS ON THE RESOURCE CHARACTERISTICS OF BIVALVES AND GASTROPODS (MF/RE/2)

P.S. Kuriakose, T.S. Velayudhan, V.K. Pillai, V. Kripa, P. Laxmilatha, N. Ramachandran, K. Ramadoss, Bobby Ignacious, P.V. Sreenivasan, R. Sarvesan, K. Satyanarayana Rao, Sujitha Thomas, Shoji Joseph and Geeta Sasikumar

BIVALVES

Green mussel. The total production of *Perna viridis* between Chaliyam and Koduvally along the Malabar coast was estimated at 5182 t. This was 618 t less than the production during the previous year. The total effort during this year was 86329 man-days and the average catch per man-day was 60 kg. The size in the catch ranged from 40 to 130 mm with modes at 55 mm, 85 mm and 110 mm. The price for 100 kg shell-on mussels varied from Rs.450 to 950 at the landing centre and at the market from Rs.550 to 1100. Spawning started from September but the spat settlement was very poor compared to the previous year. Good spat settlement occurred only at Mahe, Tellicherry and Kasargode.

Brown mussel. The total production of *Perna indica* along the Southwest coast between Trivandrum and Kolachel was estimated at 755 t. The total effort was 35033 man-days and the average catch per man-day rate was 22 kg. Spat settlement commenced in August

1997. The price of mussels varied from Rs.10 to Rs.20/- for 100 numbers at the landing centre. Ban on mussel fishing along the southern part of Kerala coast consequent on mussel poisoning, led to the decline (40%) in the catch.

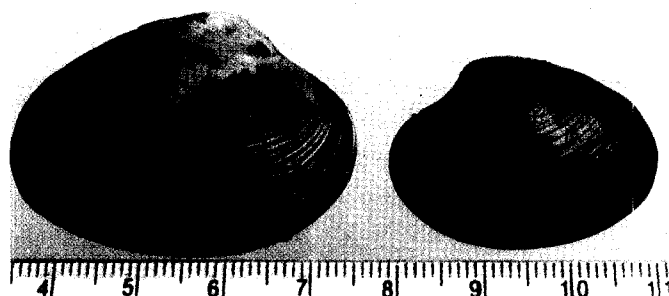
Clam. The total clam production from the Chettuva estuary was estimated at 329 t of which 92 t was accounted by *Paphia malabarica* and 237 t by *Meretrix casta*.

In the Ashtamudi lake, the production of *Paphia malabarica* was estimated at 9381 t.

The production of the black clam *Villorita cyprinoides* in the Vembanad lake was estimated at 75257 t which was 50% higher than the production last year.

The production of clams from Mulki estuary, Mangalore was estimated at 90 t. *M. casta* was the only species in the fishery with length ranging from 23-35 mm.

The total production of clams from the Kaliriver at Karwar from April to December 1997 was estimated at 140 t. *Meretrix meretrix* accounted for 98 t with the length range of 23-57 mm. The catch of *Paphia malabarica* was 42 t and the size range was 17-44 mm. About 12 t of edible oyster *Crassostrea madrasensis* was also exploited from Kali river during April-December 1997.



Paphia malabarica

The total landing of molluscs at Kakinada was estimated at 2872 t comprising 48.2% of bivalves and 51.8% of gastropods. *Anadara granosa* was most dominant forming 78.3% of bivalve landing followed by *Meretrix meretrix* (10.4%), *P. malabarica* (1.8%), *Crassostrea madrasensis* (2.5%), *K. opima* (3.9%) and others. The length range of *A. granosa* was 14-75 mm, *P. malabarica* 40-87 mm and *M. meretrix* 35-83 mm.

The survey in the Gulf of Kutch revealed populations of *Mercia opima* and *C. gryphoides* in the Miani creek.

GASTROPODS

The Chank fishery was monitored from the landing centres at Mandapam and Rameswaram and the chank collection centre at Keela karai. The total landings during April-December 1997 was estimated at 1,50,000 numbers. The size of the chanks ranged from 90 to

200 mm. 65 specimens of *Xancus pyrum* were maintained in the hatchery for conducting induced breeding experiments. A total of 160 baby chanks were reared in the hatchery. These babies were obtained from Laboratory breeding as well as wild collections. During this year 15 chanks were recaptured and their growth rate recorded. A total of 222 chanks were tagged and searached off Trivandrum.

The total estimated landings of chanks at Tuticorin was 28,00,820 numbers. Due to decontrol by the government, chanks of all sizes above 40 mm were landed.

Total landings of gastropods at Kakinada was estimated at 1484 t. *Cerithidea* sp. contributed the bulk of the landings (537 t.) followed by *Telescopium* sp. (437 t) and *Umbonium* (510 t).

SEED PRODUCTION AND RANCHING OF BIVALVE MOLLUSCS IN COASTAL WATERS (MF/CUL/4)

K.K. Appukuttan, A. Chellam, S. Dharmaraj, K. Ramadoss, D. Sivalingam, P. Muthiah,
G.P.K. Achary and P. Laxmilatha

Edible oyster: For nursery rearing of hatchery-produced edible oyster seed, 5 racks were maintained in the Tuticorin Bay. A total of 34,000 seed oyster on 709 strings were reared during the year. After the seed attained 25 mm size, they were ranched in the Korampallam creek and in the oyster beds.

Clam: In October 97, 150 *Geloina* sp of 40.5-89.1 mm size collected from Goa were received at Cochin without mortality. 90 clams were maintained in the shell-fish hatchery at Tuticorin as broodstock and the remaining clams are reared in the seawater channel of the

culture ponds. The clams kept in the hatchery were fed with mixed algae. Efforts on induced spawning by thermal and chemical methods failed.

Pearl oyster: A total production of 3.02 lakhs of pearl oyster seed was achieved in the hatchery. The maturity condition of the broodstock of pearl oysters was monitored and efforts undertaken to replenish the stock. The oysters failed to attain maturity during the peak spawning season (October-December) due to some unfavourable environmental factors.

TECHNOLOGICAL FEASIBILITY OF BIVALVE CULTURE AT SELECTED CENTRES (MF/CUL/8)

**K. Satyanarayana Rao, G. Syda Rao, E.M. Abdussamad, R. Sarvesan, P. Natarajan,
P.V. Sreenivasan, K. Ramadoss, M.K. Anil, Geeta Sasikumar and P.K. Krishnakumar**

A mussel culture demonstration at a depth of 6 m at Belamber, near Karwar, Karnataka with the participation of Fishermen Co-operative Society of Belamber was implemented. The unit (total length 30 m, floated with 30 HDPE empty cans of 35 l capacity) was launched on 11th December. Polythylene rope was used for the long line as well as anchor. A total of 36 vertical lines each with an average of 2 kg seed/m rope were hung from the main line with the help of cotton mosquito netting.

A pen culture experiment of *Geloina bengalensis* was taken up at Harwada in Karnataka, in a mangrove area. About 400 small specimens were collected

and individually marked with marker pen after removing the periostracum. A layer of Araldite was applied over the marking to prevent its loss. The marked clams were transported to the pen (20 sq.m). Growth and environmental parameters are being monitored.

Mangalore: Mussel culture demonstration was carried out in the Mulky estuary at water depth of 2-3 m, within 108 sq.m water spread area. Green mussel (*Perna viridis*) collected from Someswara, was used for seeding at the rate of 750 g/m rope. The mean size of the seed was 22 mm. Seeding was started during the last week of December. 1 m long ropes were suspended from the rack. Further seeding is in progress.

EDIBLE OYSTER CULTURE (MF/CUL/9)

P. Muthiah and K. Ramadoss

A total of 270 oyster rens were transferred to three racks erected in the Tuticorin Bay. Oysters grown on 323 strings were ranched in the Korampallam creek and oyster bed areas. During the year, 23.5 kg of

edible oyster meat was sold locally and 5 kg of meat was utilised for demonstration purposes. Regular farm maintenance work was also attended to during the period.

UPGRADATION AND TRANSFER OF TECHNOLOGY OF PEARL CULTURE (MF/CUL/10)

A.C.C. Victor, I. Jagadis, Bobby Ignatius, A.Chellam and S. Dharmaraj

Farming of pearl oysters was continued during the year, at Tuticorin Harbour Basin and Gulf of Mannar and Palk Bay near Mandapam. A total of 10 rafts (3 at Tuticorin Harbour Basin and 7 at Gulf of Mannar) were maintained. A rack of 15 m x 15 m was constructed in the Palk Bay by driving 36 nos of Eucalyptus poles into the sea bottom at 2 m depth at distances of 3 m. The oysters were grown in Gulf of Mannar and Palk Bay from October to March and April to September respec-

tively. In the Gulf of Mannar, the oysters grew faster and attained larger size than those in the Palk Bay. However, from farming point of view, both the locations are suitable.

The pearl oysters produced in the hatcheries at Tuticorin and Mandapam were supplied to various agencies for use in the onshore tanks. The details are given below.

S. No.	Place of production	To whom supplied	Total No. of spat supplied	Sale price of spat per 1000 (Rs)	Total revenue generated (Rs)
1.	Tuticorin Madras.	Gem Hatchery,	20,000	500	10,000
2.	Tuticorin Hatcheries, Visakhapatnam	Pearl Beach	10,000	500	5,000
3.	Tuticorin Tech. Pvt. Ltd. Visakhapatnam.	Pearl Aqua	30,000	250	7,500
4.	Mandapam	CMFRI, Kochi	5,000	-	-
5.	Mandapam Visakhapatnam	CMFRI, (mother oysters)	1,000	-	-
6.	Mandapam	CMFRI, Madras	2,000 (Flat oysters)	-	-

POPULARISATION AND TRANSFER OF BIVALVE CULTURE TECHNOLOGY AT SELECTED CENTRES ALONG KERALA COAST (MF/CUL/11)

K.K. Appukuttan, T.S. Velayudhan, V. Kripa, K.S. Mohamed, P. Laxmilatha, P.S. Kuriakose and N. Ramachandran

Popularisation: A rack of 80 sq m was constructed at a depth of 2 m using bamboo poles and a longline of 12 m length was moored and kept afloat by empty plastic barrels from which oyster rens and mussel ropes were suspended in the Chettuva estuary in Kerala. 300 oyster rens with spat were transported and suspended from the rack in November 1996 and 147 ropes of 1 m length with 1.5 kg seed of mussel (collected from Chettuva) were suspended in January 1997.

After 5 months, the mussels attained an average length of 55 mm from the initial 21 mm and were harvested on 5th and 6th of June. The total production was 1.5 t (meat weight 12.5%). The production per metre length of rope varied from 9.5 to 14.1 kg. A total of 197.5 kg of shucked meat was obtained.

In 7 months the oyster attained harvestable size of 55-60 mm and 23 kg of meat was shucked from the harvested oysters. The heat-shucked oysters had meat content of 6%.

About 1500 oyster rens were suspended from the rack in the demonstration farm at Dalavapuram during February-March 1997 for spat collection. Spat settlement was observed from March onwards. The growth of the 1997 recruits was monitored and compared with that of the previous year.

At Munambam, a small farm (rack) of 125 sq.m area was set up by a private entrepreneur and 200 rens were suspended from this unit. The salinity at the farm site ranged between 22 and 30 ppt.

A small longline unit of 10 m was moored off KVK, Narakkal at a depth of 3.5 m. A hapa of 1 sq.m was fabricated and about 200 broodstock of *Perna viridis* were kept in a cage within the hapa and suspended from the longline for spat collection during December 1997. Along with this, two cages stocked with 100 numbers of pearl oyster spat and 30 adult pearl oysters which were maintained at FHL, Thoppumpady.

Revenue generation: Through the sale of harvested mussel and oyster meat from the Chettuva farm Rs. 5080/- was remitted to the ICAR fund. Rs. 18,664 was generated through sale of oyster meat from the Dalavapuram farm which was sold to IFP, Cochin at the rate Rs 65/kg of shucked meat.

Transfer of technology: The simple and low cost technology developed by the Institute for farming of

mussels in backwaters has been transferred to 5 groups (each of 12-15 members of 66 rural women in two Grama Panchayats namely Cheruvathur and Valiyaparamba in Kasargod District). The North Malabar Gramina Bank and Cheruvathur Farmers Co-operative Bank provided a loan of Rs. 2,60,200 for the implementation of the project and a subsidy of Rs. 1,30,100. The groups successfully implemented the project and harvested 67.4 t of mussels from their farms in May-June 1997. A portion of the harvested and shucked meat (2000 kg) was sold to IFP, Cochin at Rs. 45/kg. The remaining harvest was sold in the local markets. The group could realise Rs. 3,34,555/- from the harvest, their net profit being Rs. 1,04,455/-, within a period of 6 months.

During October 1997, the programme was extended to 4 more groups in Kasargod District.

SELECTIVE BREEDING OF BIVALVES AND EVALUATION OF PERFORMANCE THROUGH FARM TRIALS (MF/CUL/12)

T.S. Velayudhan, P.S. Kuriakose, V. Kripa, K.S. Mohamed, and P. Laxmilatha

Broodstocks of *Villorita cyprinoides* and *Paphia malabarica* were maintained in the laboratory. *V. cyprinoides* was collected from Nettoor and Nayarambalam while *Paphia malabarica* was collected from Quilon and Chettuva. Spat and adult pearl oysters were maintained at the Fisheries Harbour Laboratory.

The broodstocks were maintained under varying salinity and feeding regimes to acclimatise them to controlled conditions. Induced spawning by thermal stimulation was attempted several times after examining gonadal condition, but were not successful, since the regulation of temperature was difficult without a Jumo thermometer.

In another experiment, 1000 specimens of *Geloina bengalensis* were transported from Karwar during December, of which about 700 were transferred to Fisheries Harbour laboratory, KVK, Narakkal and 150 numbers each to Mandapam and Tuticorin research centres for location specific studies on breeding and propagation.

The clams transferred at the FHL, were maintained at 18-22°C on mixed algae and diatom. The clams were examined a month later and found to be in mature condition. However, induced spawning by thermal stimulation proved to be futile. Further efforts are in progress.

CULTURE OF CEPHALOPODS (MF/CUL/13)

D. Sivalingam, Shoji Joseph and M.K. Anil

TUTICORIN

Three batches of egg clusters of *Sepioteuthis lessoniana* were collected from harbour area during May and two batches from Vellapatti during June and July. Egg clusters of *Sepia pharaonis* and *Sepiella inermis* were collected from Manapad during August. Washed ashore egg clusters of *S. inermis* were collected from Hare Island during December.

Sepioteuthis lessoniana : From 181 eggs, 317 hatchlings were released, but heavy mortality occurred during the first 30 days. The hatchlings (6 mm ML) attained 202 mm ML in 126 days. However, they failed to survive due to lack of aeration. Only 6 juveniles of size range 92.9 mm to 143 mm ML weighing 59-16.3 gm survived.

Sepia pharaonis : The eggs were in advanced stages of development and 44 hatchlings of average ML of 8 mm were released. The hatchlings attained 20.8-34.9 mm ML by September. However, due to decline in salinity, there was heavy mortality progressively.

Sepiella inermis : For the first time, the eggs were observed from the Tuticorin coast at Manapad. The egg clusters, black in colour, became transparent during development. Premature hatching occurred during transportation. A total of 357 hatchlings were released and by September, 132 juveniles of 12.2-18.2 mm ML survived. The hatchlings were pelagic for two weeks

and subsequently became benthic. However, due to aeration failure and drop in salinity, there was mortality and by December only 20 juveniles (11 females and 9 males) of size range 54.3-72.2 mm ML, weighing 33-64 gms survived. Gonads were in well developed condition.

The hatchlings of 2 mm ML preyed upon young mysids. The hatchlings of squid and cuttlefish accepted *Acetes*, *Aplocheilus*, *Chanos*, Mulletts and *Tilapia* besides mysids.

KARWAR

Stock culture of four species of microalgae: *Chlorella marina*, *Chaetoceros*, *Isochrysis* and *Dicrateria* were maintained successfully. Small scale cultures of different livefeed organisms like Rotifer, Copepods, *Moina* were also maintained. A stock of mysids was isolated from the zooplakton samples collected and maintained in the laboratory and feeding trials were conducted to mass culture the same. Large scale culture is not possible at present as there are no facilities for direct sea water intake, containers for culture and aeration. Small quantities of *S. inermis* and *L. duvauceli* eggs hatched successfully in the laboratory. The larvae were reared for 12 days. Different livefeed organisms as well as compounded feed were used with the available facilities. Continuous monitoring is conducted to collect cephalopod eggs.

SEED PRODUCTION AND PEARL PRODUCTION IN THE ABALONE *HALIOTIS VARIA* (MF/CUL/14)

A.C.C. Victor, Bobby Ignatius, A. Chellam and S. Dharmaraj

MANDAPAM

Work in this project was initiated at Mandapam in

May 1997. About 80 specimens of *Haliotis varia* were collected from Tuticorin Harbour and maintained in

1.5 t FRP tanks with daily water exchange. Experiments on the feed preference, anatomy etc. were carried out. *Ulva lactuca* and *Polysiphonia* sp (an encrusted red alga) were found to be most suitable feeds for the abalones.

Work on the preparation of feeding plates for larvae was initiated. *Chlorella* were grown in the laboratory in culture tanks in order to form a film over the sheets. Formation of a very thin film over the sheets was observed. Also, a type of diatom attached to the glass walls of the aquaria was isolated and cultured in the laboratory.

35 abalones were brought from Tuticorin in November 1997. Mature specimens were subjected to induced spawning, but spawning did not occur. The abalones were observed to attain maturity during fullmoon and new moon days and hence these days are suitable for collection of mature specimens. 50 animals again were brought from Tuticorin. Spawning occurred in males but the females did not respond.

In order to make the abalones mature in captivity, they were kept in oyster cages of 40 x 40 x 10 cm and suspended in the sea, providing *Ulva* as the feed. How-



Haliotis varia

ever, the animals did not attain maturity; survival was also very poor.

Attempts were made to collect abalones from Mandapam. It was found that abalones occur on the breakwaters near Manoli Island, but the density is very less and of very small size (average 2.5 cm) as compared to the bigger stock of average 4.5 cm available in Tuticorin.

TUTICORIN

Induced spawning through thermal and chemical stimulations was unsuccessful. When the abalones were kept under total darkness, they spawned spontaneously.

STANDARDISATION OF TECHNIQUES IN ONSHORE PEARL CULTURE (MF/CUL/15)

G. Syda Rao, P.V. Sreenivasan, M.M. Meiyappan and R. Sarvesan

VISAKHAPATNAM

The programme of onshore pearl culture is being implemented under consultancy in two farms on a commercial scale. One farm (Pearl Beach hatcheries Pvt. Ltd) is situated near Bhimilipatnam and the other (Pearl Aqua tech Pvt. Ltd.) is at Chepala Kancheru near

Bhogapuram. Both the farms are integrated pearl production units exclusively meant for this purpose in an area of about 1 ha each. Algal culture lab has been established and three species of phytoplankton viz. *Chaetoceros* sp. *Isochrysis galbana* and *Nanochloropsis salina* are being maintained under hygienic conditions.

Production of phytoplankton up to 20 t/day has been tested on a commercial scale at a very low cost and fed to pearl oysters. The pearl oyster spat from 5 mm were grown to 30-40 mm along with adults from June 97. A slow sand filter of high efficiency has been designed in collaboration with the Environmental Engineering experts from Andhra University and constructed, to yield good quality sea water without any chemical treatment.

The oysters have reached advanced stage of maturity under the system of broodstock development, paving the way for round the year availability of good quality brooders of pearl oysters.

About 15000 oyster stock is presently being maintained at both the places in onshore tanks and they are growing at the expected rate.

Computerised on-line monitoring of environmental parameters is being tested on a small scale in order to extend it to the entire farm area in due course.

MADRAS

Stock cultures of *Isochrysis* is being maintained. The oyster spat of 1995 and 1996 batches showed poor growth. The work is being continued in GEM hatchery. There was total mortality of pearl oyster spat

due to contamination of sea water. However 13000 spat were brought from Tuticorin in August and the work is being continued. A total 269 pearls were obtained from 1705 implanted oysters. Of them 138 were fully formed (3 mm, 103 and 4 mm, 35).

COCHIN

Onshore pearl culture experiments were carried out at FHL of CMFRI, Thoppumpady. Both adult and spat of pearl oyster were maintained in 5 and 6 tonne capacity tanks with a salinity of 28-35 ppt. They were fed with mixed microalgae comprising of *Isochrysis*, *Chaetoceros*, *Nanochloropsis* and *Chlorella* at a concentration ranging from 20-40,000 cells/ml. No water exchange was possible during the culture period.

While pearl oyster spat showed a growth from 14 to 16 mm within 70 days culture duration, the same spat transplanted in Chettuva estuary grew from 14 to 27 mm within 70 days. Adult oysters did not show any growth in length (from 64 mm to 65 mm in 100 days). The entire stock of spats (about 2500) suffered mortality after 90 days of culture. Consequently, the adult pearl oysters were shifted to a longline anchored off Narakkal at 5 m depth, where they exhibited growth. Here too, some mortality occurred due to fouling.

DEVELOPMENT OF LOW - COST TECHNOLOGY SYSTEM FOR SEAFARMING OF PEARLS AND MUSSELS (MF/CUL/16)

G.P.K. Achary, Rani Mary George, S. Jasmine, M. Sivadasan and K.P. Said Koya

Fast growth of pearl oysters was observed in the high density stocking pedestal cages and two-in-one cages. Pearl oysters farmed as breeders were sent to the Fisheries Harbour Laboratory, for onshore culture experiments. Pearl oysters were also supplied from the Vizhinjam farm for genetic studies.

New designs of cages with radial and lateral pedestals were made. This prevented the mortality of stocked animals in the event of the cages tilting sideways and coming in contact with the silty or sandy bottom.

The high density stocking cages and two-in-one



Cage with lateral pedestals

cages gave good results showing good growth for the edible fishes, ornamental fishes, lobsters and crabs. This indicates the possibility of a multi-crop farming system in the shallow sea-bottom.

Ascidians farmed as side crop were given to the Pharmacology Department of Andhra University (19 kg) and the National Institute of Oceanography, Goa (35 kg), for extraction of bio-active compounds.

An extensive survey, made around the Colachel-Muttom area, revealed the occurrence of *P. fucata*, *P. maculata* and *P. sugillata* in fairly good numbers indicating the suitability of pearl farming in these areas.

HATCHERY PRODUCTION OF THE CLAM (*MERETRIX* SP) SEED (CMFRI/SPO/3)

P.V. Sreenivasan and D. Sivalingam

Collection, transportation, conditioning and induced spawning

Broodstock of the clam *Meretrix casta* was collected from Muttukadu backwater near Madras and transported to Tuticorin Hatchery for conditioning and subsequent induced spawning. A total of 545 clams were transported in five batches to Tuticorin. Good survival of clams was recorded whenever they were acclimatised for few days in the laboratory prior to transportation and also by using limited quantity of ice, that was sufficient to keep the temperature about 20°C during transportation.

The clams brought to Tuticorin hatchery were maintained at the conditioning room as well as in the hatchery itself. They were fed intensively with microalgal diet. Induced spawning was attempted by thermal stimu-

lation at an interval of 15 to 20 days. Success was achieved on seven occasions.

Larval rearing and seed production

Totally six batches of larvae were reared during the year, leading to settlement of spat. Following are

Date of spawning	Initial larval strength	Seed produced
30.1.97	2,80,000	7,410
10.2.97	1,95,000	7,700
13.3.97	1,54,000	69,283
11.7.97	-	2,50,000
7.11.97	1,65,000	1,00,000
10.12.97	-	1,55,000

Totally, 5,89,393 clam seed were produced during the year.

the details of the batches of larvae reared and seed produced:

Nursery rearing

Seed settled were maintained in the hatchery upto 1-2 mm size, providing microalgal food. Then they were transferred to velon screen bags and placed in the seawater supply channels of the fish culture pond for further rearing until ranching in suitable sites.

Ranching of clam seed

During the year under report, ranching of clam seed was carried out in the following areas at the dates mentioned:

Month	Area	Number of seed ranching
January	Muttukadu	1,05,000
	Korampallam	1,00,000
August	Muttukadu	6,000
	Korampallam	1,25,000
October	Pulicat	1,13,250

For ranching purposes, the clam seed were transported from Tuticorin Hatchery in polythene bags containing aerated seawater. Prior to ranching, the seed were acclimatised in the laboratory for few days.

Observations were made on the growth of the ranched clam seed at Muttukadu. Details of the observations are:

Month	Length (mm)	Weight (g)
August '98	4.7	0.06
September	11.7	0.80
October	19.9	3.14
November	25.0	5.20
December	26.3	5.85

There was good growth both in length and weight among the clam seed ranching in Muttukadu backwaters.

HATCHERY PRODUCTION OF THE GREEN MUSSEL (*PERNA VIRIDIS*) SEED (CMFRI/SPO/4)

P.S. Kuriakose

There were three successful spawnings of the green mussel (*Perna viridis*) in the hatchery during the period under report. The first spawning was in February '97. A total of 2.8 million larvae were reared for 10 days up to the Umbonal stage. Survival of larvae declined from the Umbonal stage to the settling stage and the percentage of survival was 20 (0.56 million). The percentage of spat settled in the rearing tank was only 4 (0.112 million). The spat settled (0.112 million) were reared further for 60 days in the nursery tanks until they attained 13-15 mm length. The Juvenile mussels from the nursery have been transferred to the mussel culture farm at Dharmadam.

The second induced spawning experiment was conducted in April and 1.6 million larvae were reared for 10 days upto the Umbonal stage. The survival of the larvae was very poor and only 65000 spat settled in the rearing tanks. The very low survival rate was due to the sudden deterioration of water quality consequent upon the occurrence of dinoflagellate bloom (*Noctiluca*) in the coastal water.

The third spawning experiment was conducted in October. A total of 1.6 million larvae were reared for 10 days. The percentage of spat settled at the end of 18th day was 5 (0.08 million). The spat settled in the

hatchery were reared further for 55 days to attain a size of 10-15 mm length. The 0.08 million seed produced were transferred to the mussel culture farm of the DWCR group at Cheruvattur for further growth.

Stock cultures of 5 species of phytoflagellates were well maintained in the hatchery. Outdoor mass cultures of phytoflagellates and phytoplankton have been

developed in 1 tonne capacity FRP tanks for feeding the broodstock, larvae and the Juveniles in the nursery.

The second induced spawning experiment was conducted in April and 1.6 million larvae were reared for 10 days upto the Umbonal stage. The survival of the larvae was very poor in this also, due to the dinoflagellate bloom. Only 6500 spat settled in the rearing tanks.

TISSUE CULTURE IN PEARL OYSTER (CMFRI/SPO/6)

S. Dharmaraj

Encouraging results were obtained in the first attempt to culture cells *in vitro*. Crystal formation by the epithelial cells of pearl oyster mantle occurred in *in vitro* condition. However, contamination due to

inadequate sterilization occurred. Efforts to prevent contamination were stepped up. Effect of antibiotics was also studied. Explant culture of *P. sugillata* was also organised.

COMMERCIAL PROPAGATION OF MARINE PEARL CULTURE TECHNOLOGY (CMFRI/SPO/7)

A.C.C. Victor, A. Chellam, D. Kandasamy and I. Jagadish

Studies on the rearing of pearl oyster spat and adults, nucleus implantation and rearing for pearl production under onshore conditions and mass rearing of hatchery produced spat under onshore conditions were carried out during the year.

Rearing of pearl oyster spat in on-shore tanks: Spat of 10-24.9 mm size were transferred into 30 t capacity tanks. The oysters were kept on the specially designed PVC racks of 8'x7' size with central partition and the racks had two tiers with one foot gap between each tier. Nylon nets of 10 mm size were used in the fabrication of the racks. The water available to each oyster per day was 4 litres, with 50% water change everyday. The oysters were fed with mixed algal culture with

Chaetoceros sp dominant. The available cell concentration in the water ranged from 0.6 to 1.4 lakh cells/ml. The monthly growth rate was 1.0 mm.



Rearing pearl oyster spat in onshore tanks at Mandapam

Nucleus implantation and pearl production: A batch of 484 nucleated oysters of 30-57 mm size and 10-25 g (operated during June 96 using 3 and 4 mm) were under rearing in exclusively tank condition. The available water for each oyster was 10 l. Daily water exchange was also provided. After a period of 12 months, 130 oysters survived (27%) and were harvested. 98 oysters were bearing the nucleus which accounted for 74% retention of nucleus. 55 oysters had pearly coating (56%) and the rest without any coating.

Preliminary observations on the onshore tank culture of nucleated oysters indicated poor growth and poor secretion of nacre.

Mass rearing of hatchery produced spat under onshore conditions:

Hatchery produced spat of the size ranging from 1-9 were stocked in 1.5 and 5 ton FRP tanks in uniform density of 10,000 nos/t of water and provided with continuous aeration and feed at 1 lakh cells/1 mm size of spat per day. 100% water exchange was resorted to once a week. The duration of the experiment was 80 days. Periodical mortality of spat was observed while changing the water. At the end of the culture period the spat attained a growth of 3.2 to 12 mm (6.1 mm) and the survival rate ranged from 16 to 36.3% in the different tanks. The average growth obtained under the tank condition was 2.3 mm/month.

COMMERCIAL PRODUCTION OF CULTURED PEARLS ADOPTING ONSHORE TECHNOLOGY

A.C.C. Victor, A. Chellam and I. Jagadish

Rearing of oyster spat in Gulf of Mannar and Palk Bay

Rearing of two consignments of oyster spat transported from Tuticorin Research Centre was continued. The first consignment of 16,500 numbers of 3.2 to 12.3 mm size range were monitored for growth upto six months. The spat were reared in box type cages at a stocking density of 1500 numbers/cage and suspended from floating rafts. Periodical thinning was carried out. After six months, the oysters had attained the size of 34.6 to 51.8 mm, showing a monthly growth rate of 6.3 mm. The survival was 50%. These oysters were used for implantation subsequently. The second consignment of 50,000 spat of the size 7.7 to 21.8 mm transported during March were reared in the Gulf of Mannar for a period of 1 1/2 months and they attained a growth of 15.2 to 34.5 mm size. These were transferred to the Palk Bay due to rough weather prevailing in the Gulf of Mannar and the culture was continued upto October 97, the spat attained a size of 29.3 to

40.0 mm after 5 months. The oysters were again transferred to the Gulf of Mannar when conditions became rough in the Bay and were grown upto December 97. The spat attained an average size of 40.3 mm.

About 2.75 lakhs of spat produced in the hatchery were shifted to the sea during August 97. The average size of the different spawning groups ranged from 0.7 to 3.5 mm. The spat stocked in five velon netted cages, within a period of 3 months attained an average size of 19.1 mm. The first thinning was done during November-December 97 and about one lakh spat were recovered which worked out to 36.4% of the total stocked in the sea.

Larval transport and rearing

During January 97, a consignment of 10 lakhs 'veliger' larvae (58-72 μ) were successfully transported to Mandapam and reared in one ton FRP tanks adopting standard larval culture methods, using *Isochrysis galbana* as feed. On 28th day about 40000 spat

(0.5 mm) settled. This was 4.0% of the larvae under rearing. The rearing was continued upto 3 months and about 14,000 spat of size 6.1-10.4 mm (8.0 mm) were raised and transferred to Palk Bay sea for further rearing. About 5,000 spat of 20 mm size were supplied to Headquarters and the remaining oysters were cultured and had grown to a size of 29.5 - 38.5 mm (33.3) over a period of seven months (November '97) and about 6000 oysters are surviving. The rate of survival was high (79%). The fast growing oysters are segregated and used for regular implantation.

Induced spawning and larval rearing

A total of 7 spawnings was achieved during June-August '97 and about 1 crore larvae were collected of which 80 lakh larvae were reared under hatchery condition. The survival upto spat stage ranged from 4.3 - 16.0% in different spawnings and the average was 8.4%. About 6.7 lakhs spat (1.0 - 3.0 mm) were produced successfully in the first run of the hatchery.

In November two spawnings were noticed but larval rearing failed due to unprecedented rain and lowering of salinity. During December '97 two spawnings yielded 65 lakhs of larvae and were reared and about 1.4 lakh spat of 1.0 - 3.0 mm size was produced.

Nucleus implantation

Nucleus implantations were carried out during January-March '96 (2, 100 nos.), June '96 (484 nos) and '96 (180 nos) and December '96 (132 nos) and were cultured under onshore (544 nos) and offshore (2352 nos) conditions. The culture duration ranged from 9 to 14 months.

Apart from the experiments, efforts were made to develop the infrastructure facilities. A full fledged pearl oyster hatchery with proper drainage channels with a capacity to produce 28 million larvae and 2-8 million spat per run was developed. Six offshore rafts (3 x 3 m) were constructed and moored in the sea to serve as offshore facility to hold oysters.

Details of spawning experiments

S. No.	Date	No. of larvae produced (in lakhs)	Date of settlement/size range	No. of spat produced (above 1 mm)	% spat recovery
1.	26.6.97	10	16 130-140μ	75,000	7.5
2.	14.7.97	20	16 150-200μ	3,20,000	16.0
3.	8.7.97	15	20 150-225μ	1,00,000	6.6
4.	12.7.97 13.7.97 14.7.97	35	17 192-216μ	1,50,000	4.3
5.	23.8.97	10	16 140-180μ	75,000	7.5
6.	7.11.97 25.11.97	30 5	Larval mortality due to salinity lowering		
7.	13.12.97	15	30 180-225μ	40,000	3.0
8.	28.12.97	50	25 180-200μ	1,00,000	2.0

VI. FISHERY ENVIRONMENT MANAGEMENT DIVISION

During the period under report, the Division implemented 13 Research Projects of the Institute and 2 Sponsored Projects.

INVESTIGATIONS ON ENVIRONMENTAL PARAMETERS OF INSHORE WATERS IN RELATION TO FISHERIES (FEM/ES/1)

C.P. Gopinathan, V. Chandrika, S. Muthusamy, T.S. Naomi, Pon Siraimethan,
V.V. Singh, P.K. Krishnakumar, S. Krishna Pillai, M. Rajagopalan,
K. Vijayakumaran, and P.T. Sarada

COCHIN

The water temperature ranged from 24.0°C to 29.0°C, salinity from 17.28 to 32.68 ppt; dissolved oxygen from 2.72 to 5.04 ml/l; nitrite from 0.45 to 2.30 ug at/l; nitrate from 0.21 to 5.21 ug at/l; phosphate from 1.21 to 3.35 ug at/l and silicates from 0.89 to 3.61 ug at/l in the water column of the inshore area.

The productivity measurements in terms of chlorophyll *a* revealed that the inshore area of Cochin, between 10 to 20 m region is highly productive during the period May to August (2.47 to 9.07 mg/m³) while the phaeo-pigments were dominated during the month of August only in the inshore area.

The zooplankton biomass values were the highest (18.37 ml/m³) at 20 m depth zone in July and the lowest (0.44 ml/100 m³) at 10 m depth in August. Copepods, ostracods, siphonophores and decapod larvae were abundant at 20 m depth zone during July. Cladocerans, larval decapods, chaetognaths, amphipods etc. were also predominant at the 20 m depth zone during June-July. Zooplanktons in general were less abundant in August and September.

MANGALORE

The sea surface temperature varied from 27.2 to 31.2°C while bottom temperature varied from 26 to 29.8°C at 10 m. Lowest surface temperature was

recorded during August at 10 m. Dissolved oxygen at the bottom showed declining trend from July and recorded lowest value of 0.86 ml/l during September at 10 m and 1.29 ml/l at 20 m. The surface and bottom pH values showed declining trend with the onset of south-west monsoon during June.

High phosphate and nitrite values were observed at the surface during June and July and silicate content showed increasing trend with the onset of monsoon. The surface chlorophyll *a* content varied from 0.218 to 0.522 mg/m³, while the bottom values ranged from 0.177 to 0.583 mg/m³ at 10 m depth. Surface and bottom chlorophyll *a* content was high during April and May while it was moderate and low during July and Sept. The productivity at 20 m was high when compared to the one at 10 m depth. The zooplankton biomass varied from 0.1 to 0.26 ml/m³ and was high during May and September at 10 m.

KARWAR

The SST in Karwar Bay declined from 29.85°C in May to 27.15°C in August, while bottom temperature declined from 30.30 to 26.95°C in August. Surface salinity varied from 23.76 ppt in April to 5.27 ppt in August while bottom salinity varied from 30.71 ppt in May to 20.42 ppt in June. The surface dissolved oxygen in the bay varied from 4.02 ml/l in April to 5.02 ml/l in August, while the same at the bottom varied from 2.97 ml/l in May to 4.42 ml/l in June.

The primary production values of surface waters of Karwar bay varied from 102 in June to 203 mgC/m³/day in May.

BOMBAY

The SST in the nearshore station ranged from 29.5 to 33.5°C, pH from 7.5 to 8.0; salinity from 18.61 ppt to 25.15 ppt. The dissolved oxygen content was in the range of 3.77-4.14 ml/l.

The values of silicates in the nearshore station ranged from 29.43 to 82.92 µg at/l while the phosphates were in the range of 1.27 to 7.8 µg at/l. The values of nitrite ranged from nil to 2.85 µg at/l while the values of nitrate varied from 7.44 to 51.76 µg at/l. The values of chlorophyll *a* were in the range of 0.51 to 28.23 mg/m³ suggesting the high productivity of waters in the inshore area of Bombay.

MINICOY

The SST ranged from 28.6 to 30.5°C, the salinity from 33.2 to 35.5 ppt and the dissolved oxygen from 3.4 to 5.7 ml/l in the inshore waters of Minicoy. The values of nitrite, nitrate, phosphate and silicate varied from 0.67 to 1.98; 0.8 to 4.4; 1.0 to 1.97 and 0.58 to 0.94 µg at/l respectively. All the above nutrients were recorded minimum values in May.

The gross primary production (22.3 mgC/m³/hr) and net primary production (7.8 mgC/m³/hr) were found to be high during June, indicating high fertility around Minicoy Island.

TUTICORIN

The SST varied from 25.5 to 29.8°C and the dissolved oxygen from 4.14 to 4.56 ml/l. The salinity was found to be in the range of 35.52 to 36.2 ppt while the pH varied from 7.78 to 8.01 in the water column.

The values of primary production varied from 39.45 mgC/m³/day to 235.55 mgC/m³/day in the water column of the inshore area during this period. The volume of zooplankton for 10 minutes surface haul ranged from 0.5 ml in April to 6.4 ml in May. Phyllosoma larvae were observed in May and fish eggs and larvae were dominant during July. A bloom of *Trichodesmium* was observed in the inshore waters during April.

MADRAS

The SST ranged from 26.2 to 29.0°C, the salinity values were in the range of 29.3 to 34.0 ppt and the dissolved oxygen from 3.0 to 5.7 ml/l

KAKINADA

The SST varied from 26.0 to 32.6°C and the salinity from 32.17 to 34.44 ppt while the dissolved oxygen content varied from 2.84 to 3.74 ml/l. The SST was high during May and decreased till July and thereafter showed an increase upto September. The salinity decreased till September. Comparing the two quarters, a declining trend from first quarter to the second quarter for all the parameters was noticed.

VISAKHAPATNAM

The data collected on sea surface temperature, salinity and dissolved oxygen suggested moderate upwelling throughout the first quarter. At the open sea station, the surface salinity was at a peak of 34.65 ppt during the second week of April, and declined to 33.40 ppt during third week of May. Salinity values remained more or less steady above 34 ppt during the rest of the first quarter. Compared to the corresponding quarter of 1996, the mean salinity values did not show any significant difference during April and May; the value was slightly higher during June, whereas the mean surface temperature was slightly less than that of the same period of last year.

BIOLOGICAL PRODUCTIVITY OF THE INDIAN EEZ IN RELATION TO OCEANOGRAPHIC PARAMETERS (FEM/SS/1)

V. Narayana Pillai, V.K. Pillai and K.G. Girijavallabhan

One cruise was undertaken along SW coast of India onboard FORV *Sagar Sampada* for validation of the Modular Optoelectronic Scanner (MOS) onboard the Indian Remote Sensing Satellite IRSP-3. This involved simultaneous measurement of various optical, meteorological and oceanographic parameters at the time of Satellite overpass on 12th and 17th April, 1998,

during the validation cruise. The data were utilised for the preparation of Algorithm and correction factors for validation of MOS data being obtained from IRSP-3. Real time surface chlorophyll data assumes great significance in the preparation of PFZ advisories along with SST data in view of its influence on herbivores like oil sardine.

ECOLOGICAL INVESTIGATIONS ON THE INTERTIDAL AND SURF ZONES OF THE KERALA AND KANYAKUMARI COASTS IN RELATION TO FINFISH AND SHELL-FISH SEED RESOURCES (FEM/ES/6)

G.S. Daniel Selvaraj, Molly Varghese, S. Krishna Pillai, and S. Jasmine

Investigations were carried out at Calicut, Cochin and Vizhinjam from the surf regions of the sea and adjoining intertidal estuarine systems namely, Korapuzha, Cochin backwater, Panathura, Veli, Perumathura, Parathiyoor, Thenkaipattinam and Manakudi. Data on surface water temperature, salinity, dissolved oxygen, nutrients, primary productivity and availability of fish and prawn seed were collected and analysed.

In the intertidal surf zone, surface water temperature ranged from 28.7-31.5°C at Calicut; 25.7-30.8°C at Cochin, 26.5-30.3°C at Vizhinjam and 26.5-30.8°C at Kanyakumari. Salinity values ranged from 17.8-34.2 ppt at Calicut, 16.1-34.3 ppt at Cochin, 26.2-35.9 ppt around Vizhinjam and 26.8-35.0 ppt around Kanyakumari. Dissolved oxygen values ranged between 3.0 and 5.0 ml/l around Kochi, 3.0-6.3 ml/l around Vizhinjam and 4.5-5.8 ml/l around Kanyakumari. In general, the surf water around Calicut showed lower values and that around

Kanyakumari showed higher oxygen values during 1997.

Among nutrients, phosphate, nitrite and nitrate values were higher in the surf waters around Cochin than at Calicut. While phosphate values showed the peak of 5.53 ug at/l in July, nitrite and nitrate values showed their peak of 10.5 and 9.1 ug at/l respectively during May in the Kochi waters.

Mean net primary productivity values ranged from Nil to 0.554 gC/m³/d around Cochin while it reached the maximum of 1.03 gC/m³/d at Calicut. In general, the values were higher during premonsoon months in the intertidal surf waters during 1997.

Among prawn juveniles, *Metapenaeus dobsoni*, *M. monoceros* and *P. indicus* were common. *M. dobsoni* contributed more than 70% to the catch. Juveniles of *M. dobsoni* were more throughout the year while that of *M. monoceros* during January-March and *P. indicus* during April-June.

MONITORING OF THE STATE OF HEALTH OF COASTAL WATERS IN RELATION TO POLLUTION AND AQUACULTURE ACTIVITIES (FEM/MP/1)

V.K. Pillai, P. Krishnakumar, M. Rajagopalan, P. Kaladharan, D.C.V. Easterson,
S. Krishna Pillai and P.S. Asha

COCHIN

Samples for hydrography and sediment were collected from four stations covering from estuary to 20m depth off Cochin. Biological samples were also collected and analysed for heavy metals.

Comparatively higher levels of ammonia (total) were recorded in the estuarine waters during June-August period (maximum of 102.83 $\mu\text{g at/l}$ during June 1997) and nitrate nitrogen levels were also high (24.03 $\mu\text{g at/l}$ during July '97) in the same period. However, in the other months the levels were near normal. This phenomenon was noticed in the previous years also. The source of the higher level during monsoon period is probably from the industries situated upstream.

Fin and shell fish samples (7 samples and six species) collected from the inshore waters were analysed for heavy metals (viz. Cu, Zn, Cd & Pb); the levels were found to be within the permissible levels for seafood.

The sediment samples showed higher values during the postmonsoon period (Sept.-Oct. '97; Zn: 195 $\mu\text{g/g}$, Cu: 45.5 $\mu\text{g/g}$ and Pb: 43/5 $\mu\text{g/g}$ respectively).

MANGALORE

Monthly seawater samples were collected off Chithrapur, near the effluent discharge point of the Mangalore Refineries and Petrochemicals Ltd. and analysed for chemical and biological parameters. Dissolved oxygen content was in the normal range of 5.03 to 7.5 mg/l and biochemical oxygen demand varied from 0.97 to 2.27 mg/l . Higher BOD values were reported during May-June. Nitrite content varied from 0.1 to 1.82 $\mu\text{g at/l}$ and phosphate content varied from 0.35 to 1.13 $\mu\text{g at/l}$. Silicate levels varied from

8.18 to 37.7 $\mu\text{g at/l}$. The chemical oxygen demand varied from 21.5 to 45.8 mg/l .

The chlorophyll *a* content and zooplankton biomass were measured during April and May. Chlorophyll *a* content varied from 0.57 to 0.67 mg/m^3 and zooplankton biomass varied from 0.04 to 0.07 ml/m^3 . The quality of the coastal water off Chithrapur, receiving the effluent discharge from the Petroleum Refinery was found to be within the tolerance limits prescribed by the Karnataka State Pollution Control Board.

The large scale oil contamination on the beaches extending over 150 km along Karnataka coast during June 1997 was investigated. Relatively large amount of oil was found on the beaches of Padubadric and Hejmadi (217-260g/sq.mt.). The subsamples were analysed for oil and grease content which were found to be varying from 27% to 57% respectively. The magnitude and extent of oil deposited on the beaches of Mangalore ruled out the influence of any industrial discharge and the origin of the oil may possibly be from the residual fuel oils carried by any oil tanker or similar source.

TUTICORIN

Monitoring the coastal waters in the Karapad Bay and Kayalpatnam inshore waters continued during the year.

The pH of sea water in the Karapad Bay was 8.01 to 8.02 during April to July while the same ranged between 7.98 to 7.08 during August-September. During the same period in the open sea, the pH ranged from 7.28 to 8.46. Very low dissolved oxygen values were recorded in the Bay during September

(1.53 to 1.92 ml/l), but on the average the dissolved oxygen level was around 2.5 ml/l. The water was highly turbid (150.2 units) close to the thermal station effluent discharge site showing a gradual improvement (10-30 units) opposite the Karapad Laboratory.

In the Kayalpatnam inshore area, during October-December, the oxygen and pH values were lower in the lagoon compared to the inshore waters. The mercury level in water was rather low

during this period due to the opening of barmouth and also due to rainfall during this season.

MADRAS

Regular collection and analyses of physico-chemical and biological data were carried out from nearshore waters of Ennore. The water temperature ranged from 25.6 to 28.5°C and the dissolved oxygen ranged from

2.5 to 3.9 ml/l. Data on ammonia, phosphate, nitrite, nitrate and hydrogen sulphide in the seawater from Ennore area were also collected.

VIZHINJAM

The Paralytic Shellfish Poisoning reported during the first week of September 1997 from Mulloor village near Vizhinjam was investigated by the Scientists of CMFRI with the help of the expert from Fisheries College, Mangalore. Seven persons were reported to have died due to this poisoning after consuming mussels collected from the coastal area. Mussels and water samples were collected and analysed. According to the expert, the source of the toxin could be either cyanobacteria or dinoflagellates. It was observed that a heavy bloom of phytoplankton was observed in the coastal waters during the period. Further studies are in progress.

SEAWEED INVESTIGATIONS - RESOURCE ASSESSMENT OF SEAWEEDS AND THEIR CULTURE (FEM/SW/1)

V.S.K. Chennubhotla, N. Kaliaperumal, Pon Siraimetan, Reeta Jayasankar and Gulshad Mohammed

Exploitation

Field culture *Gracilaria edulis* was carried out from June to September '97 on long line coir ropes and coir rope nets at 1.5 meter depth in the Palk Bay and in the fish farm. The growth in the sea was good initially but later due to grazing by fishes and sedimentation, the growth was affected. The seedlings introduced in the farm degenerated after one week due to poor photosynthetic activity of the cultured seaweed caused by the turbidity of water in the pond and heavy attachment of sediments over the seed material.

Data on the quantity of seaweed exploited during April-September, '97 from the natural seaweed beds along Tamil Nadu coast were collected from 10 centres. The quantity harvested during the period was



Enlarged view of the multiple shoots of *Gracilaria edulis* produced in the tissue culture laboratory at Visakhapatnam research centre

estimated as 2407 t (dry weight) consisting of 1790 t of *Sargassum* spp., 144 t of *Turbanaria* spp., 249 t of *Gelidiella acerosa*, 224 t of *Gracilaria edulis*.

Culture

Gelidiella acerosa and *Gracilaria edulis* introduced in the rope culture on 18.6.97 showed good growth initially and later due to the technical problem in pumping system, the stock material deteriorated. Again the seed material of *Gracilaria corticata* and *Hypnea musciformis* was introduced and they are showing good growth and the work is in progress.

A coir rope (3 cm diameter) with seed material (*G. edulis*) of 10 cm length and 0.350 kg weight was introduced on 16.4.97 near the northern side of Hare Island, near Tuticorin. The rope was tied to *Casurina* poles in an area of 1.6 sq.m. and the net was fixed 0.5 m above the bottom. Harvesting was made after 86 days on 5.7.97 and obtained a yield of 4.66 kg. The production rate was estimated as 29.13 t/ha in 86 days.

After the harvest, the same coir rope with 0.4 kg seed material with the same length of the plant was reintroduced in the same site on 20.6.97.

G. edulis was cultured in the Minicoy lagoon using longline coir rope method for periods of 114 days and 83 days. Heavy grazing was noticed here. During periodic visits heavy sedimentation was noticed on the ropes; periodic cleaning was done.

G. edulis and *G. corticata* var. *corticata* were selected for culture at Fisheries Jetty site. Long line coir rope method was adopted for a period of 112 days and 83 days. Heavy grazing was noticed here also but sedimentation was less.

G. edulis was cultured at the Harbour site using long line coir as well as nylon ropes. In coir ropes for a period of 56 days, a weight increase of 4.85 times was obtained. No grazing was observed here and sedimentation was negligible.

G. edulis, *Caulerpa sertularioides* and *Hypnea valentiae* are cultured at Park site. *G. edulis* cultured on long line coir rope for 85 days recorded a 12 fold increase in weight, while on long line nylon rope for 63 days recorded 3.75 fold increase only. No grazing was there.

BIODIVERSITY STUDIES (FEM/AR/1)

P.A. Thomas

The study on the taxonomy of alcyonarians revealed the availability of three genera: *Sinularia* May, *Lobophytum* von Marinzeller and *Sarcophyton* Lesson. Species of these genera are commonly available in Indian seas.

Species can be identified on the basis of spicules,

especially their length, seen inside the sterile stalk or on the basis of spicules seen on the surface of capitulum.

At the request of the different research groups, sponge specimens collected from different localities along the Indian coast were identified to the species level.

SANITARY SIGNIFICANCE OF FAECAL COLIFORMS IN SELECTED COASTAL ENVIRONMENTS GROWING MARINE SHELLFISHES (FEM/MB/1)

V. Chandrika

To assess the water quality in the molluscan culture sites, a new approach was developed using clams and

oysters as bio-indicators and coliforms as faecal pollution indicators. Monthly samples collected from

Dhalavapuram area, were studied for faecal *Streptococci* using water, sediment and Sentinel organisms like clams and oysters as they concentrate the faecal pollution indicating bacteria. A high number of 'FC' and 'ABR-FC' were detected in all the six observations conducted so far. Faecal coliforms isolated (*E.coli*) were studied in detail for their

antibiotic sensitivity and of the 26 *E.coli*, 18 were found to be multi-drug resistant. The data suggest that clams and oysters can be used as bio-indicators of faecal pollution in preference to direct testing of water & sediment. The multiple drug resistance of *E.coli* indicates the possibility of R + factor in their plasmids with transferable drug resistance.

MARICULTURE OF LIVEFEED ORGANISMS (FEM/LF/1)

K.G.Girijavallabhan, C.P. Gopinathan, P.Kaladharan, T.S. Naomi, Rani Mary George, S. Jasmine, Molly Varghese, Reeta Jayasankar, M.Rajagopalan, P.T. Sarada, K. Vijayakumaran, D. Sivalingam and D. Kandaswamy

Maintenance of microalgae under laboratory conditions (*Isochrysis*, *Dicrateria*, *Chromulina*, *Chaetoceros*, *Chlorella*, *Nannochloropsis*, *Tetraselmis* etc.) was continued at Cochin. Inoculum of these microalgae were given to various hatcheries. At the Fisheries Harbour, the culture of rotifers, *Brachionus plicatilis* using *Nannochloropsis* and *Chlorella* as feed was attempted. Culture of rotifer in the open tanks having a capacity of 500 litres was also carried out. A new system is being developed by using more than one or two tanks interconnected to have a continuous

harvesting system to be used as feed for fish larvae and crustacean larvae.

At Minicoy, the culture of certain marine zooplankton especially copepods which can be used as live feed is in progress.

At Vizhinjam, seven species of microalgae and rotifer *Brachionus plicatilis* are maintained. Microalgae *Chlorella* and *Isochrysis* are being used as feed for rotifer.

At Visakhapatnam, the required infrastructure is being developed.

CONSERVATION OF MARINE TURTLES (FEM/MT/1)

M. Rajagopalan, S. Krishna Pillai and K.M.S. Ameer Hamsa

Data were collected on the stranding and mortality of turtles and dolphins in Orissa coast in April 1997. During this season, mass nesting of olive ridley *Lepidochelys olivacea* did not occur. About 5000 dead turtles were noticed along the Gahirmatha beach; the mortality was due to incidental catch in fishing gears. The composition of dead males and females was 27% and 73% respectively. The mortality of 10 dolphins along the Gahirmatha beach in 1997 season was also

due to the entangling in the fishing gears. Humpback dolphin *Sousa chinensis*, finless black porpoise *Neophocaena phocaenoides* and Snubfin dolphin *Orcaella brevirostris* were observed on the beach in different states of decay.

In September 1997 sanction of the ICAR was accorded for the ad-hoc research scheme for 'Conservation of Green turtle *Chelonia mydas* and a preliminary survey was made along the Gujarat coast.

BREEDING, SEED PRODUCTION AND SEARANCHING OF SEACUCUMBER *Holothuria scabra* (FEM/HOL/1)

D.B. James and P.S. Asha

Attempts on spawning by thermal stimulation continued. During the two trials in October '97, spawning did not take place. Northeast monsoon started from second week of October bringing down the salinity drastically. Similarly, spawning did not take place in the trials conducted in November 1997. On 29.11.97, an experiment was started in the laboratory to test the effect of phytoplankton bloom and fixed day length on the gametogenesis in *H. scabra*. In a separate one tonne tank, five sea-cucumber (avg. length and weight of 223 mm and 390 gm respectively) were

maintained as a control. They were fed with same food and exposed to normal day and night hours.

Three specimens of *H. atra* collected from harbour area during October 1997, were devoid of mouth and tentacles, and were considered as posterior pieces and two specimens were found to be developing their posterior portions as small buds. These five pieces were kept in a separate 100 l tank for observations on regeneration. These specimens suggest the occurrence of binary fission among seacucumbers in nature.

ULTRASTRUCTURAL STUDIES OF MARINE ORGANISMS (CMFRI/IDP/EM/1)

K. Rengarajan, K.C. George, P.C. Thomas, N.K. Sanil, N. Sridhar and K.S. Shobana

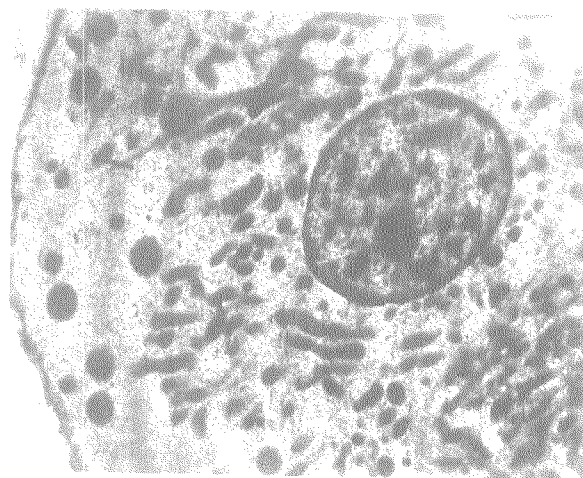
Eggs, sperms and larvae of Pearl oyster, edible oyster, clams and seacucumber and some of the commercially important fin fishes were observed both in TEM and SEM. Different processing techniques were tested and observations repeated for better results, due to the microscopic nature of the specimens. However, the results are encouraging. Further work is progressing.

To study the ultrastructure of the immune cell of *Tilapia mossambica* and absorption of carbon particles, 0.5 ml of colloidal carbon was injected into the peritoneal cavity. After varying time intervals, the spleen and kidney were dissected and processed for TEM. Leucocytes with ingested carbon particles as round dark dots were observed in TEM and photographed.

Healthy *Tilapia* were injected with 0.5 ml Freund's adjuvant to study the inflammatory reaction at the site of injection and ultrastructural alternations and the tissues

were processed for TEM. The work is in progress.

The Electron Microscopy Laboratory facility was made available to scientists and faculty members of other research organisations and universities; reasonably good amount was realised to the ICAR/CMFRI fund.



Electron micrograph of a leucocyte of *Tilapia mossambica* with absorbed carbon particles as round dark dots (mag. 10,000 x)

PREPARATION OF GUIDE FOR EGGS AND LARVAE OF INDIAN MARINE FINFISH (CMFRI/IDP/EL/2)

K.J.Mathew, P.Bensam, N.G.Menon, P.N.R.Nair, Grace Mathew and T.S.Naomi

The documentation part of the work on characters of the larval stages of teleosts in the Indian EEZ progressed. The various developmental stages were grouped under standard classification such as early egg, middle egg, late egg, larva preflexon post-larvae, flexon post larva, post flexon post-larva and juvenile. The writeup part on the above aspects for the following species has been completed.

Rachycentron canadum, *Ranzania laevis*, *Rastrelliger neglectus*, *Remora remora*, *Sardinella dayi*, *Scarus caeruleus*, *Scomber australapicus*,

Scomberomorus commerson, *S.maculatus*, *Sebastodes paucispinis* and 12 other species of Sebastodes. Accounts were also made for *Albula vulpes*, *Mugil cephalus*, *Ambassis gymnocephalus*, *Amphiprion percula*, *Arnoglossus tapeinosoma*, *Bothus ocellatus*, *Laeops guntheri*, *Solea ovata*, *Cynoglossus monopus*, *Stolephorus tri*, *Decapterus russelli*, *Saurida tumbil*, *Hemirhamphus far* and *Triacanthus brevirostris*.

The illustrations for the first mentioned group of species have been completed.

DEVELOPMENT OF ARTIFICIAL SEA WATER FOR AQUACULTURE (CMFRI/IDP/AS/1)

P.Natarajan, R.Thiagarajan, Grace Mathew, P.Nammalwar, K.Vijayakumaran and P.Kaladharan

Experiments on the culture of *Chlorella* sp. were continued with different types of culture media developed under the Project and comparisons were made with the longevity of cells with conventional

culture solutions. It was found that a declining trend in the newly developed media occurred after a longer duration when compared to conventional culture solutions.

CULTIVATION OF AGAR YIELDING SEaweeds UNDER GREENHOUSE CONDITION (CMFRI/SPO/9)

N. Kaliaperumal

Experiments on *Gracilaria edulis* were carried out in fibreglass tanks with running seawater system under greenhouse condition by pretreating the seed material with 2 mg, 4mg, 6mg, 8mg or 10 mg/l concentration of Ascorbic acid for 12 hours. Control was also maintained without pretreating the seed material. These experiments were conducted for a period of 30 days. Maximum increase in biomass (83%) was found in

control. Among the plants treated with different concentration of ascorbic acid, greater increase in biomass (73%) was obtained in the plants treated with 8 mg/l concentration than all other concentrations.

Another set of experiment was initiated by pretreating the seed material of *G.edulis* with 3 mg/l concentration of Indole Butyric acid. This experiment is in progress.

APPLICATION OF REMOTE SENSING TECHNOLOGY TO MARINE FISHERIES (CMFRI/SPO/11)

**V.N. Pillai, C.P. Gopinathan, V.K. Pillai, M.Srinath, M. Ferozkhan,
Rani Mary George and M. Sivadas**

Validation of PFZ forecasts received from the NRSA, during January-May and November-December, 1997 and also January-March, 1998 was undertaken along the Kerala coast and around Minicoy Island. Positive Correlation for Pelagic fishing activities such as gill netting, purse-seining, trolling and tuna pole and line fishing activity with PFZ was obtained. In the case of tuna pole and line fishing operations around Minicoy Island, the average catch of Skipjack tuna (*Katsuwonus pelamis*)/boat has shown 300% higher yield in PFZ

showing a definite correlation between PFZ and Skipjack tuna catches. Pole and line fishing for Skipjack tuna being a pelagic fishing activity is aimed at a single pelagic resource which is known to be very much influenced by seawater temperature and hence the positive correlation. The PFZ forecasts were translated into the local language and passed on to the end users directly and also through the local dailies and AIR broadcasting through Trivandrum, Trichur and Calicut Stations.



VII. PHYSIOLOGY, NUTRITION AND PATHOLOGY DIVISION

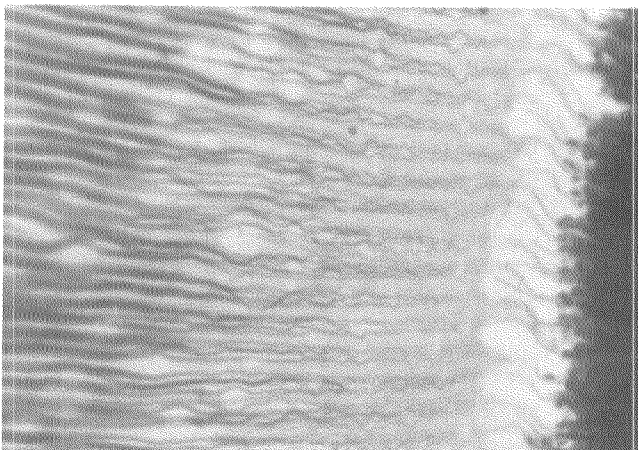
DEVELOPMENT OF FEEDS AND OPTIMIZATION OF FEEDING REGIMES FOR CULTURABLE CRUSTACEANS, MARINE FINFISHES AND PEARL OYSTERS (PNP/35)

R. PaulRaj, M.Vijayakumaran, D.Kandasami, Preetha Panicker, D.C.V.Easterson, Manpal Sridhar and P.Vijayagopal

Protein energy interaction studies in *Penaeus indicus*. Nine semipurified diets containing shrimp meal, fish meal, groundnut oilcake, clam meal, tapioca flour and albumin were designed to contain 35, 40 and 45% protein and 3.8, 4.2 and 4.6 kcal/g of gross energy at each protein level. These diets were evaluated in a 3³ factorial experiment conducted with juveniles of *Penaeus indicus* of <1 g initial weight to arrive at the optimum P/E ratio. The results suggest a progressive increase in absolute growth rate (AGR), relative growth rate (RGR), food conversion ratio (FCR), food conversion efficiency (FCE), protein efficiency ratio (PER) and productive protein value (PPV) without any statistically significant variations. However, in this size of shrimps, protein levels alone significantly ($P < 0.01$) affected AGR, RGR, FCR, FCE, PER and PPV. Energy levels alone did not have any significant effect.

Evaluation of fermented mantis shrimp and wheatbran-based diets on the performance of *Penaeus indicus*. A set of ten compounded diets were formulated each incorporating mantis shrimp meal and wheatbran individually fermented with both *Beauveria* spp. fungi and bacillus *B.licheniformis* at concentrations of 20, 40, 60, 80 and 100%. The results of study on the nutritional performance of postlarvae (initial weight: 0.19 ± 0.06 g) reared on these feeds for a period of 45 days indicate improved growth performance and percentage carcass yields in animals fed on the fermented feeds. Feed intake was lower in experimental animals and led to a reduction in overall feed usage and higher feed conversion ratios.

Vitamin C requirement of *Penaeus indicus*. In order to examine the nutritional pathology of vitamin - C in *Penaeus indicus* the seawater in which the shrimps were to be reared was made vitamin free by passing the freshly filtered seawater through a column (12 mm dia. and 3 mm height) of activated charcoal. Presence of vitamin - C if any was monitored. Subsequently the gut microbes in the experimental shrimps were attempted to be removed by feeding antibiotics. Sulphamycin mixed diets which were found to be the most effective for this purpose were given fed for three days to the experimental shrimps prior to the start of feeding experiments. The test diet contained vitamin free caesin 42g, potato starch 12g, codliver oil 6g, cholesterol 0.05g, mineral mixture (USP XIV) 5g, vitamin - C free vitamin mixture 5g and binder 8g, filler and vitamin - C in graded levels of 2000 ppm (standard diet); 1750, 1500, 1000, 250 and 0 (deficient diets). The results revealed that vitamin - C is essentially required above 1500 ppm, though maximum growth was observed at 2000 ppm level. The deficiency signs manifested were soft cuticle, weak gills which were reduced/malformed or atrophied. The muscles were oedematous and showed loss of rigidity, mononuclear infiltration and vacuolation. In some shrimps muscles became opaque and hepatopancreas showed degeneration and necrosis. Nervous cells showed degeneration and the eye nerves became vacuolated and detached. The vitamin - C free diet fed animals on feeding with enriched diet showed no marked improvement or reversal of symptoms.



Degeneration of ommatidial nerve endings due to Vitamin C deficiency in *Penaeus indicus*

Feeding trials with mudcrab: Feeding trials were carried out with compounded dry diets prepared with the protein mix of fish powder (crude protein 55%), shrimp powder (crude protein 45%) and soyabean meal (crude protein 45%) along with wheat flour, codliver oil, calcium phosphate, calcium carbonate, vitamin premix, ascorbic acid, cholesterol and guar gum as the binder. Pellet diameter ranging in size from 4 to 7mm were prepared to suit the growing mudcrabs. Juveniles weighing 34.5 to 54.5 g grew to 47.5 to 65 g weight (excluding moult weight) in 105 days under laboratory conditions. The weight of exuvia accounted for about 36 % of the body weight of juvenile crabs. Thus a substantial amount of nutrients are lost during moult. Diets containing ascending levels of protein from 20% to 50% have been formulated to determine the optimum level.

Feeding trials with spiny lobster: Two experiments were conducted with juvenile lobsters *Panulirus homarus* using the formulated feed for mud crab and clam meat. Compounded feed pellets were not accepted even after addition of clam

extract as an attractant. Further improvement in the pellet composition, binder, attractant mix and texture is being made. Juvenile lobsters (CL 40 - 40 mm and weight 50 - 126 g) showed gains of 2 - 5.5 mm in CL and 3 to 33.5 g weight after 30 days of rearing with clam meat.

Viability of dormant cysts of *Artemia*, rotifers and *Moina*:

The dormant cysts of *Artemia*, rotifer and moina were collected from the culture tanks, dried and preserved for future use as the stock culture and easy transportation. The duration of the viability of stored dormant cysts in low and high saline water, low

temperature (-14°C) and in dried condition were studied. It was found that the rotifer and moina cysts are viable upto 6 months in dried condition and thereafter the hatching rate decreased.

Organic medium for *Chlorella*, diatoms and flagellates:

Chlorella has been successfully cultured using extracts of peanuts, channa, raw rice, boiled rice and wheat as media. Extracts of seeds from casuarina, accacia and nail-dye plant, naval fruit, horsegram,



Degeneration and necrosis in hepatopancreas of *Penaeus indicus* due to Vitamin C deficiency

greengram, peanut and fresh waste eggshell extract were compared. Among these, the extracts from casuarina, Accacia, nail-dye plant induced significant improvement in growth of *Isochrysis galbana* (2.5 million cells/ml in 4-6 days), extract from egg shell, casuarina and iodine solution are found to be suitable for the culture of *Chaetoceros* spp. (5.6 lakh cells/ml/day). The diatoms and flagellates cultured in the organic medium, when fed to *Penaeus semisulcatus* protozoa 1 to PL 1 produced the best response with 90.2% survival.

Feeding rate of pearl oyster spat: Spats of size 10 - 14 mm were weighed and stocked in 2 l glass beakers at a stocking rate of 1 spat/100 ml seawater. Duplicates were maintained for each treatment. The tested cell concentration ranged from 1 lakh to 6 lakh cells. Survival, growth, total food consumed and faecal output were recorded. The environmental parameters were temperature 27°C to 30°C, salinity 30 to 35 ppt,

dissolved oxygen 3.5 to 4.5 ml/l and pH 8.2 to 8.3 during the experimental period.

The experiment showed that spat fed at the rate of 6 lakh cells/day/spat showed maximum growth of 0.026g. The group fed 4 lakh cells and above showed gradual growth increment.

Feeding of groupers: Groupers were maintained with a diet of fresh sardines at 10% body weight. Live *Tilapia* were also regularly released into the culture tank. Feed was offered once daily in the afternoon and the feed left over was collected to determine the actual consumption. Grouper seeds 47 -87 mm (mean 68.2 mm) and mean body weight of 4.5 g are reared on chopped sardines at the rate of 15% body weight once daily in the afternoon during the first 3 months and thereafter they are fed at 10% of their body weight and water exchange was 75% daily. The growth increment was 1.87 mm and 1.26 g per day.

EFFECT OF ENVIRONMENTAL STRESSORS ON THE PHYSIOLOGICAL BEHAVIOUR OF CULTIVABLE MARINE BIVALVES (PNP/44)

M. Peer Mohamed, A. Noble and S. R. Krupesh Sharma

The following molluscs were tested for their salinity tolerance levels at 29.5°C through four sets of experiments during the year. Their ranges of salinity tolerance and optimum salinities were as follows :

Species	Tolerance	Optimum
<i>Crassostrea madrasensis</i> (20 -25 mm)	5 -45 ppt	30 - 35 ppt
<i>Paphia malabarica</i> (9 - 12 mm)	5 -30 ppt	10 - 15 ppt
<i>Meretrix casta</i> (41 - 45 mm)	5-25 ppt	15 ppt

DISEASE INVESTIGATIONS IN MARINE FINFISH AND SHELLFISH (PNP/46)

M. Vijayakumaran, R. Paulraj, A.P. Lipton, N.K. Sanil, S.R. Krupesh Sharma, Gaurav Rathore and Preetha Panikkar

Shrimp Diseases: The Whitespot disease syndrome continued to affect shrimp culture in different systems in Tamilnadu and Andhra Pradesh. Shrimp farming was in low key due to restrictions imposed by the apex court

and disease appeared in many farms starting from 20 to 30 days of culture. The relationship between adverse environmental conditions like heavy rainfall, flooding and reduction in temperature was found to

influence the impact, intensity and spread of disease. While chlorination and use of probiotics continued, many conventional and unconventional drugs and chemicals were also tried by some farmers. Tissues of whitespot affected shrimps have been processed and blocks made for transmission electron microscopy. Redspot disease of epidemic proportion was detected in one farm growing *Penaeus monodon* and the farmer resorted to immediate harvest. Slow growth rate and mortality in one of the farms growing *Penaeus monodon* was detected to be due to excessive growth of benthic algae. The problem could be tackled by appropriate remedial measures and by resorting to low stocking density.

Incidence of whitespot disease in commercial prawn catches from Madras was reported in January 98. Attempts to quantify the incidence and intensity of the disease in commercial catches revealed definite symptoms of the disease in more than 20% of *Metapenaeus dobsoni*, the dominant species landed in Madras fisheries harbour. Efforts are now being made to confirm the early detection method by correlating it with

staining methods. This is the first report on the incidence of whitespot disease in *Metapenaeus dobsoni*.

Lobster diseases: Many lobsters in a lobster holding centre were in poor health conditions with tail fin rot and bulging of arthroal membrane between carapace and abdomen which is a definite indication of stress. Shell lesions were also detected in few lobsters.

One of the main stressors that decrease the survival of spiny lobsters during holding and transport was detected to be dissolved ammonia in holding tanks as well as in tanks used for sudden chilling prior to live packaging. The ammonia concentration in the rearing tanks where lobsters were stocked at 28 kg/m² was 0.75 ppm, despite continuous aeration and partial water exchange.

Temperature of water was 28-29°C, pH 8-8.5 and dissolved oxygen 5-7ml/l. Ammonia concentration in the chilling tank with 420 litres of water increased from almost nil to more than 1 ppm in 30 minutes after chilling 160 kg (542 pieces) of lobsters. The trader was advised to use different chilling tanks to reduce the effect of ammonia.

FORMULATION OF NUTRITIONAL STRATEGIES FOR THE MANAGEMENT OF AQUACULTURE WASTES(NSMAW) THROUGH LOW-POLLUTION DIETS FOR SHRIMPS (PNP/47)

Manpal Sridhar, M.Peer Mohamed and P.Vijayagopal

Of the conventional and nonconventional ingredients examined, the animal protein sources showed comparatively higher nitrogen content (12.74 in the case of blood meal a non-conventional ingredient to 7.30 in the case of meat meal another non-conventional feed ingredient). All the conventional animal protein ingredients had nitrogen content in the range of 7 to 9. Among the vegetable protein sources, soyabean meal recorded highest nitrogen content of 8.15 followed by groundnut oil cake with a value of 6.22. All other plant ingredients had comparatively lower nitrogen contents. Meat meal

gave the highest phosphorous content of 5.18 followed by fresh fish meal and clam meal with values of 3.61 and 3.65 respectively among the animal protein sources. Amongst plant ingredients, tapioca flour gave the highest phosphorus content of 2.09 followed by wheatbran with a value of 1.49 and ricebran 1.41 respectively. However, when the P/N ratios were computed all ingredients gave P/N ratio less than one, excepting for tapioca flour which gave a value of 7.74.

Based on the above ingredients, two feeds were formulated. Feed C, the control feed was so formulated

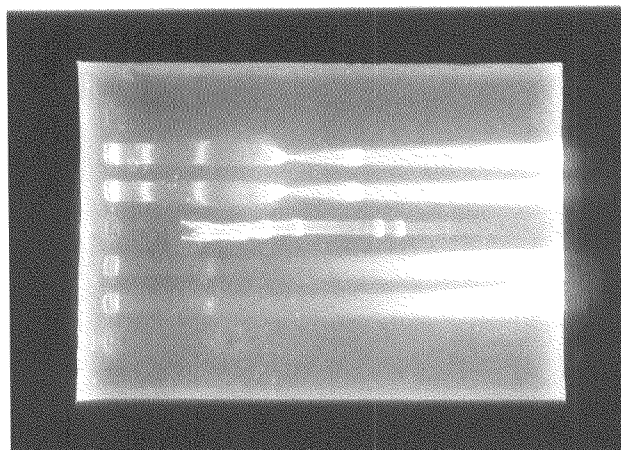
to give a P/N ratio of >1. Feed D, the experimental feed was formulated to give a P/N ratio of <1. These feeds were given to *Penaeus indicus* juveniles (initial weight 1.49±1.0.28 g) for a period of 30 days and growth as well as P and N contents of the water were monitored.

Results of this experiment showed significant differences between growth performances of control and experimental groups. Further experiments to assess the apparent digestibility coefficients of high nutrient dense (HND) diets are in progress.

DEVELOPMENT OF DNA FINGERPRINTS AND PROBES FOR DIAGNOSIS OF PATHOGENS OF FINFISH AND SHELLFISH (PNP/48)

P.C.Thomas and M.K.George

Three bacterial species identified as major fish pathogens viz., *Vibrio parahaemolyticus* and *V. harveyi* and *Aeromonas hydrophila* were cultured in laboratory and both nuclear DNA and plasmid DNA from them were isolated using the alkaline lysis method modified and standardized for the purpose. These DNAs were checked for purity, integrity and yield, spectrophotometrically and by electrophoresis. Restriction digestion of DNA using type II endonucleases were carried out to generate restriction fragments and for the preparation of restriction maps. Since genomic DNA had numerous restriction sites for these enzymes, it was impossible to resolve the innumerable fragments in the submarine agarose gel electrophoresis. Hence, experiments with enzymes having rare cutting sites are underway to generate less numerous fragments. Chemical



Plasmid DNA profile of *Vibrio parahaemolyticus*
Lane 1 & 2: *V. parahaemolyticus* ATCC strain with single plasmid
Lane 3: Standard DNA marker
Lane 4 & 5: *V. parahaemolyticus* field strain with multiple plasmids

cleaving of the plasmid DNA of *V. parahaemolyticus* with Pst. I resulted in three fragments of 9.5, 6.0 and 4.5 kb size. No restriction sites for Ecor. I could be detected.

POPULATION GENETIC STUDIES IN *RASTRELLIGER KANAGURTA*, *SARDINELLA LONGICEPS* AND *PENAEUS INDICUS* (PNP/49)

M.K.George, P.C.Thomas and P.Jayasankar

To study the restriction fragment length polymorphism (RFLP) in mt DNA isolated from the species were first digested by two of the restriction enzymes, viz., ECOR I and BamH I. The digested samples were then analyzed by agarose gel electrophoresis.

The separated mt DNA fragments were detected by ethidium staining. The ECOR I and BmaH I produced two fragments of mt DNA in the specimens tested. The estimated total size of the fragments was 21 kb.

GENETIC STUDIES ON MARINE PENAEID PRAWNS (SPO/12)

M.K. George and N.N.Pillai

The genetic variations at aldehyde oxidase (AO), aldolase (ALD), octanol dehydrogenase (ODH), alpha glycerophosphate dehydrogenase ((GDPH) enzymes loci in the samples of *Penaeus indicus* from Madras and Kakinada and additionally, esterase (EST) and malate dehydrogenase enzymes loci in the samples of *Penaeus monodon* from Madras and Kakinada were studied by gel electrophoresis methods. Morphometric variations

were also studied in these two samples.

The level of genetic variability was high in both the species as indicated by average heterozygosity values of about 0.14 in *Penaeus indicus* and 0.16 in *Penaeus monodon*. The preliminary analysis of the allele frequencies in the regional samples of the two species showed that the values were not significantly different.

INDUCED MATURATION OF GROUPERS (PNP/50)

M.Peer Mohamed, N.Sridhar, Manpal Sridhar and D.Noble

The procedure for making 17 methyl testosterone incorporated pellets was standardized. Experiments were initiated at the fisheries harbour laboratory as well as Narakkal for interconversion of female group-

pers to male groupers by feeding the pellets once in three days initially and later at an interval of 2 days. The pellets had an incorporated hormone level of 8 mg to 12 mg depending upon their weight.

IN VITRO EFFECT OF NEUROHORMONES ON OVARY DEVELOPMENT IN CRUSTACEANS (PNP/51)

N.Sridhar and M.Peer Mohamed

To identify the precursor amino acid tyrosine and other biogenic amines in the hepatopancreas and ovary of shrimp *Penaeus indicus* during different phases of maturation, a procedure using thinlayer chromatography was standardised with butanol:acetic acid and water (12:3:5) as the solvent mixture. The amines Dopa, Dopamine and norepinephrine and epinephrine were identified by the ferric chloride ferricyanide reagent. The identification procedure is also currently being carried out with 5-hydroxy tryptamine a biogenic amine, known to play a role in maturation of ovary in crustaceans.

Vitellogenesis proceeds with the onset of maturation of ovary along with increased activity of certain lipogenic enzymes which as glucose-6-phosphate dehydrogenase and malate dehydrogenase (NADP). To know the profile of these two enzymes in the ovary and hepatopancreas of shrimps the assay conditions

of these enzymes were standardised using NADP as the second substrate. The absorbance was read at 340nm. The activity of the enzymes was also determined in the ovary and hepatopancreas of *Macrobrachium rosenbergii*, *Penaeus indicus* and *P. monodon*. The glucose-6-phosphate dehydrogenase activity in the hepatopancreas of *M. rosenbergii*, *P. indicus* and *P. monodon* was 0.24, 0.1309 and 0.1739 OD units /mg protein/min respectively whereas in the ovary the activity was 0.43, 0.36 and 0.42 OD units/mg protein/min respectively. The malate dehydrogenase activity in the hepatopancreas of *M. rosenbergii*, *P. indicus* and *P. monodon* was 0.214, 0.109 and 0.208 OD units/mg protein/min. Assays are being performed to know the profile of these enzymes in the ovary and hepatopancreas of shrimps during various stages of maturation.

STUDIES ON THE EFFECT OF TOXINS, POLLUTANTS AND PROBIOTICS ON FISH HEALTH WITH SPECIAL REFERENCE TO IMMUNE SYSTEM (PNP/52)

K.C.George, N.K.Sanil and K.S. Sobhana

The effect of aflatoxin B₁ on the immune system and various vital organs was studied. The aflatoxin reduced feed intake and liver appeared pale in most of the cases. When dose of the toxin increased, it produced hemorrhages in the liver. Hepatocytes were vacuolated and in many areas of liver, focal necrosis was noticed. In kidneys, remarkable changes were noticed. Tubules showed severe degenerative changes. Glomeruli had

undergone thickening. Interstitial and haematopoietic tissue was rarefied. Spleen revealed disruption of ellipsoids and necrosis of lymphoid cells. There was severe fall in haematocrit values.

Immunological studies revealed severe suppression of antibody production in aflatoxin treated fishes. There was also fall in total protein, albumin and globulin values.

EXTRACTION AND ISOLATION OF SUBSTANCES OF PHARMACOLOGICAL IMPORTANCE FROM MARINE ORGANISMS (PNP/53)

N.Sridhar, P.Kaladharan, P.A.Thomas, G.P. Kumaraswamy Achari,
K. G. Girijavallabhan and A.P.Lipton

Abalones (*Haliotis* sp.) collected from Tuticorin were subjected to extraction of gut enzymes in alkaline phosphate buffer (pH 7.5, 0.1 M). The enzyme was concentrated using chilled acetone (-20°C) using solvent fractionation technique. The precipitate obtained was isolated by centrifugation at 500 r.p.m. for 20 min. and redissolved in minimum quantity of buffer and stored with 1% glycerol at -20°C. The enzyme is currently being tested for concentrations of enzyme and agar.

A blue green alga, (BGA) *Lyngbia* sp. growing attached in silpolin lined ponds at Narakkal was tested for the presence of agarase activity. The crude enzyme extract was isolated in phosphate buffer (pH 7.5) and the activity assayed upon 1% agar slants using the phenol sulphuric acid methods for estimating the hydrolysed carbohydrate using glucose as the standard. The results showed 50% solubilization of 1% agar after 3 hours of addition of the enzyme extract. This shows the strong possibilities of using BGA as a source of agarase enzyme.

Attempts are being made to concentrate this crude enzyme preparation.

Caulerpa racemosa collected from Rameswaram was tested for the presence of cytokinin, a growth promoting substance used in tissue culture experiments. The methanol extract was condensed by evaporation under vacuum and purified by passing through a column of CM-cellulose, a cation exchange resin. The cytokinin like substances eluted from the column is stored at (-20°C) for assay of its activity on root elongation. The above preparations after sufficient concentration and purification can be readily utilised for seaweed based biotechnological work.

Simultaneously procedures for culturing ascidians, sponges, corals, polyzoans, crinoids, bryozoans etc. having extracts of pharmacological importance are continued to produce these organisms as side crops.

VIII. SOCIO-ECONOMIC EVALUATION AND TECHNOLOGY TRANSFER DIVISION

The Division carried out five research projects besides involving in technology transfer programmes and acquiring macro-level data on fish markets and costs and earnings of different craft-gear combinations. The fish marketing data reveal that the fishermen's share in consumers' rupee varies from 37% to 83% in Gujarat, 31% to 81% in Maharashtra, 31% to 71% in Karnataka, 26% to 71% in Kerala, 30% to 67% in

Tamil Nadu and 17% to 53% in Andhra Pradesh for different varieties of fish. At the all India level, the fishermen's share in consumers' rupee ranges from 30% to 68% for different varieties. Marketing costs including transportation range from 6% to 13% of the consumers rupee. Wholesalers receive 5% to 32% and retailers from 14% to 47% of consumers rupee for different varieties of marine fish.

EMPOWERMENT OF COASTAL COMMUNITIES THROUGH FISHERIES EXTENSION (FE &E/31)

Krishna Srinath, R. Sathiadhas and Sheela Immanuel

Special component Plan for SC/ST

An amount of Rs 2.5 lakhs was sanctioned by the Ernakulam District Administration for taking up crab culture, ornamental fish culture and fish culture integrated with poultry at Chellanam. A short term training was imparted to 25 beneficiaries by the scientists of CMFRI and CIBA. Seed of milk fish was collected from Poothotta fish farm (Matsyafed), *Etroplus* sp. from CIBA fish farm, Narakkal, and Mullet from KAU farm at Puthuvypu. Crab seed was collected from an established commercial crab farm at Kuthiathodu, Alleppy. The seeds were stocked in the farmers' field in the month of September. Aquarium fishes such as gold fish, carp, and white and black mollies were collected from private Aquaria. Poultry birds were purchased from KAU Mannuthy (Trichur) and given to the fishermen. The ornamental fishes were stocked in 5 cement rings of 1m x 1 m size. Technical guidance was provided by the Scientists of CMFRI. Regular monitoring was done.

The ornamental fish farmers were shown the functioning of biofilter system. They were also helped to purchase a country boat to transport freshwater. The

crab stocked in the farms were harvested after a period of 5 months. Each crab attained the weight of around 1 kg. An estimated yield of 100 kg per farm was achieved. A harvest mela was also organised on this occasion. The District Planning Officer and the Assistant General Manager, NABARD were present in the function. Live crabs were also exhibited.

Awareness Campaign

A labour awareness campaign was organised at Kandakadavu in collaboration with the Workers' Education Centre and Chellanam Panchayat. The campaign, dealing with labour rights and their problems was organised for five days. Fifty fishermen/women labourers attended the programme.

Programme under "Development of women and children in rural areas"

A group of 11 fishermen were identified under the DWCRA programme to take up ornamental fish culture at Maruvacaud, Chellanam panchayat. An amount of Rs 1.65 lakhs was sanctioned for this project. An area of 44 cents was taken on lease to take up this culture. Pond preparation was done under the guidance of



Involvement of women under the DWRC in mussel culture at Padanne

CMFRI. Angel fish and Gourami were stocked. In addition to this, under the same scheme, two sub projects on crab culture and finfish culture were also sanctioned

and the work is being initiated. An amount of Rs 1 lakh was sanctioned for the *Mahima* feed production unit at Valappu through the AMSF Society. The building construction for the feed unit is under progress.

To the Kandakadavu society a total of Rs 3 lakhs was sanctioned for fish processing unit. The work is under progress.

Field trip/visit:

A field visit was organised for the fisherwomen under the DCWRA scheme to an established commercial ornamental fish farm at Kadachenanthai, Madurai. The five ornamental fish farmers at Chellanam were also taken to the field trip.

INTEGRATION OF SMALL SCALE MARICULTURE WITH SMALL SCALE FISHERIES ALONG THE PENINSULAR INDIA (FE & E/32)

M. Devaraj, A. Regunathan, N. Kaliaperumal, P. Jayasankar, A.C.C. Victor, D. Sivalingam, P.V. Srinivasan, M. Vijayakumaran, S. Syda Rao, G. Mohan Raj, K. Vijayakumar, N. Ramakrishnan, Krishna Pillai, R. Sathiadhas, Krishna Srinath, Sheela Immanuel, K.K. Appukuttan, P.O. Kaladharan, P.S. Kuriakose, C. Muthiah, Prathibha Rohit, Arpita Sharma, Phillipose and I. Jagadish.

A demonstration on seaweed cultivation was conducted at CMFRI fish farm, Mandapam Camp. Cultivation of agar yielding seaweed, *Gracilaria edulis* was carried by vegetative propagation at 1.5 m depth in the Palk Bay, by using long line coir ropes and 2x2 m size coir rope nets. The seaweed was harvested after 30 days. The demonstration motivated a good number of entrepreneurs to take up this technology.

At Vizhinjam, a demonstration farm was set up for lobster culture and training was imparted to the local fishermen.

A viable collection and conditioning technology

was perfected and a marine aquarium consisting of 23 tanks each of one tonne capacity and two tanks of 5 tonne capacity each was established at Vizhinjam. All the tanks are specially designed with undergravel filters and airlift systems. This was opened for the public.

Breeding of freshwater ornamental fishes was taken up at the Vizhinjam Research Centre to develop alternate employment opportunities to the coastal fishermen. Twelve varieties of freshwater ornamental fishes were bred at the newly set up breeding centre. More than 600 young ones are being maintained at the centre.

RESOURCE MANAGEMENT AND SOCIO-ECONOMIC SURVEY OF SMALLSCALE FISHERIES IN LAKSHADWEEP ISLAND AND KERALA (FE&E/33)

R. Sathiadhas, D.B.S. Sehara and Krishna Srinath

The first phase of the work programme on resource assessment and socio-economic survey at Lakshadweep and Kerala has been accomplished. In Lakshadweep there are about 5,600 fisherfolk involved in active fishing by 550 traditional crafts, 300 motorised boats and 415 mechanised boats. The household survey of sample fishermen families in Kavaratti Island was completed.

The study in Kerala indicates that the share of non-mechanised sector in total fish production decreased from 49% in 1983 to 4% in 1996. Currently the average annual per capita production was 43 t for mechanised units, 36 t for motorised units and 0.7 t for non-mechanised units. The average catch per trip of a trawler was 235 Kg comprising 42 kg of prawns and 193 Kg of fishes. The average gross earning per trip

was Rs 3,587. The net operating income of a trawler was about Rs 995 per trip and Rs 2.24 lakh per annum.

The average annual net operating income of a motorised gillnet was Rs 29,000 and a motorised unit with hooks and line Rs 37,870. The annual gross revenue realised for a ring seine in Kerala was Rs 28 lakhs from the annual catch of 19.5 tonnes. The net operating income of a ring seine was Rs 608 per trip and Rs 1.03 lakh per annum. The ring seine operations are labour-intensive and the annual fishing trips are coming down year after year and thereby creating substantial unemployment among the fishing labourers. The enhanced inputs and decline in catch rates was led to the increase in cost of production of marine fish.

A STUDY ON DIFFUSION AND ADOPTION OF SELECTED MARICULTURE PRACTICES (FE&E 34)

Sheela Immanuel and Jiju P. Alex

A total of 120 fishermen engaged in culture activities was selected from the fishing villages in and around Cochin using simple random sampling procedure to study the diffusion and adoption pattern of the technologies.

Profile of the fishermen community

Among the respondents interviewed, 42% belonged to middle age group (36-50 yrs) and 35% to old age group (>50 years) and young age (<35 years). Majority (61%) of them have primary education. 62% of the respondents have fishing as their main occupation and the remaining involved in fishery related occupations. 42% of the fishermen are living in tiled houses.

Most of them (69%) have nuclear family and 45% have less than five members. 45% of the fishermen are possessing less than 10 cents of water bodies.

The income of majority (54%) is less than Rs 10,000 per annum. Most of them (63%) are members of the fishery cooperative society and/or Harijan Society. Only 40% of them have undergone training in the mariculture practices. 60% of the respondents reported that they did not have any contact with the extension agencies. Radio is used as a source of information by 90%, television by 76% and news paper by 75%. Only 10% of them have availed loan for fishing purpose.

Extent of adoption of crab culture practices

All the fishermen are collecting the seeds from the wild. Bund construction is done by 76%, cleaning of bund by 74%, deepening of pond by 22% and fencing by 80%. Salinity and pH is tested only by 24% of the farmers. 10% of them reported to test the temperature and dissolved oxygen, whenever needed. Only 56% of them are reported to do selective stocking and the remaining stock the seed as such. Recommended stocking rate is adopted only by 36% of the farmers. All of them are using trash fish, clam meat and other animal waste as feed. Recommended feeding frequency and quantity of feed is adopted by a few farmers. Regular monitoring of the farm is done by 92% of the fishermen. 80% of them are harvesting the matured crabs (marketable size) and the remaining 20% harvest them partially as and when financial constraints are faced. Fattening of crabs is practised by 40% of the fishermen.

Prawn culture

Only 12% of the respondents are reported to get seeds only from hatchery, 8% from the wild and hatchery and 80% from the wild alone. Pond preparation is practised by 80% of the fishermen. Water is tested by 50% for salinity and pH. 38% of them are reported to have done selective stocking. 90% of the farmers are giving some quantity of artificial feed while 10% of them are not giving additional feed. Regular monitoring is done by 75%. 94% of them are harvesting matured prawns.

Other mariculture practices

Edible oyster, mussel and *Mahima* feed technologies are adopted only by a few farmers. At Dalavapuram and Cannanore, the CMFRI propagated the technology among a group of farmers.

Interviews with farmers practicing these technologies revealed that:

- a. A few farmers have comparatively high socio-economic background.

- b. The main source of information was the scientists of CMFRI
- c. The farmers are willing to continue the technology, but to confirm the feasibility few more demonstrations are required.
- d. They face constraints in marketing the product.
- e. The labour charge and labour requirement for shucking of meat are quite high.

Cooperative societies can be established for proper marketing and maintaining reasonable price. It is also desirable that state level functionaries should come forward in extending financial assistance/subsidies to make adoption a success.

***Mahima* shrimp feed**

The source of information about *Mahima* shrimp feed is the CMFRI scientists. Some of the fish farmers learnt from their neighbours. The farmers reported that the physical appearance, quality and water stability of feed are good. Some of them reported that the price is comparatively high when compared to the locally prepared feed.

More demonstrations and extension efforts are required to popularise the use of this feed..

Diffusion of information

In a multi-response survey, 90% of the farmers reported that mass media are the important source of information followed by personal cosmopolite sources (72%) and personal localite sources (70%).

Responses of fishermen on constraints in adoption of scientific technologies

1. Nonavailability of seeds from the hatchery for prawn farming (35%)
2. Risk in scientific prawn farming is greater than in traditional farming (15%).
3. Investment is higher in scientific farming (40%).

- | | |
|--|---|
| 4. Lack of technical guidance (12%) | 7. Land leasing problem (10%) |
| 5. Sudden outbreak of diseases 40% | 8. Labour problem during the harvesting time (50%) |
| 6. Lack of financial support to take up the technology (22%) | 9. Lack of awareness of the technology (combined responses for all the technologies)(80%) |

EVALUATION OF SOCIO-ECONOMIC CONDITIONS AND ERGONOMICAL PROBLEMS OF WOMEN ENGAGED IN PRAWN PEELING IN MUMBAI REGION (FE&E/35)

Arpita Sharma

The study showed that the work conditions and socio-economic conditions of these women are poor.

Most of the women are illiterate and are aged around 31 years. The mean monthly income of these women is found to be only Rs 781/-. The work hours are irregular as the work depends on the catch. Piece rate wage system is adopted here and on an average they are paid Rs 1.50 per kg of prawn peeled.

The posture adopted by all the women during work is squatting on floor/patla. They are exposed to occupational disorders like musculo-skeletal pains in

different parts of the body. It was found that 90% of the women suffer from pain in the lumbar region. Shoulder pain and scapular pain are also found to be high probably due to continuous squatting with forward bending of the back. Most women suffer from finger and palm injuries due to prick of rostrum, while peeling prawns. Due to continuous squatting, they also feel numbness in the foot and calf regions and often experience pins and needle sensations in the foot. All these cause disability and reduce their efficiency and productivity resulting in low wages. All this coupled with their low socio-economic status is making their conditions dismal.

TECHNOLOGY ASSESSED AND TRANSFERRED

A simple and low-cost technology has been developed for farming of green mussels in estuaries and backwaters. The production potential and feasibility of mussel farming has been proved through demonstration programmes conducted at Padanna, Kasargod district and Dharmadam, Kannur district by involving the local fishermen. During 1997, this technology has been transferred to five groups of rural women, each comprising 12 to 15 members, living below the poverty line in Cheruvathoor and Valiaparamba panchayats in Kasargod district, Kerala under IRDP/DWCRA programme. The project was financed by North Malabar Gramin Bank and Farmer's Co-operative Bank,

Cheruvathoor. From an investment of Rs. 2,60,200/-, a return of Rs. 3,34,555/- could be realised within a period of five months. The beneficiaries were given 50% of the project amount as subsidy. Encouraged by the high production and profitability of backwater mussel culture, four more groups have adopted this technology during the current year.

Under the technology transfer programme, the Mangalore Research Centre has successfully demonstrated farming of mussels in the Mulky estuary, about 35 km north of Mangalore during 1997. Racks and rens were used for the culture of green mussel, *Perna*

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Involvement of women in mussel farming along the Kerala coast

viridis. Seeds (mean size : 19.2 mm) sourced from Someshwara, 10 km south of Mangalore were seeded to ropes of one metre length with a seeding rate of 2 kg/m. Mussels were harvested on 2-6-1997 in the presence of officials from the State Fisheries Department and press persons. During

December 1997 a group of five small-scale fishermen were encouraged to take up mussel culture at Mulky estuary under the technical guidance of the Research Centre. The Brackishwater Fishfarmer's Development Agency (BFDA), Government of Karnataka has made available a sum of Rs. 10,000/- to this demonstration project. Mussel seeds (mean size : 22 mm) were seeded on one metre length using coir ropes at a seeding rate of 750/1500 g per m length. A total of 440 such ropes were suspended from the racks.



Small-scale fishermen seeding mussel on ropes for culture at Mulky, Karnataka

EDUCATION AND TRAINING

Postgraduate Programme in Mariculture

Under the Postgraduate Programme in Mariculture, a total of about 3230 manhours (2230 manhours for teaching at Master's degree level, 1000 manhours for course work of Ph.D.) was devoted by the scientists in teaching.

Under the M.F.Sc. programme, the 14th batch (1995-97) comprising 11 students, completed the course and all of them have been declared passed securing a maximum O.G.P.A. of 8.25/10. The 15th

batch (1996-98) comprising 8 students completed the second and third semesters of regular course and admissions were made into the final semester for dissertation work. The 16th batch (1997-99) comprising 10 students (including the 5 joined earlier for the deficiency course), completed the first semester and were admitted to the second semester.

Under the doctoral programme, 7 candidates of the earlier batch were awarded the Ph.D. degrees by the



Dr. R. S. Paroda, Director General ICAR, speaking to M. F. Sc and Ph. D. students of CMFRI at Cochin

the research work and submitted thesis for adjudication. As regards the students admitted under the Deemed University (CIFE), one belonging to the 12th batch has completed the work and submitted thesis for adjudication. The thesis work of the other two students of the batch have neared completion. The students of the 13th batch (1995-98) numbering four have progressed well in their research work and those of the 14th batch (1996-99) numbering ten took up research work after completion of their course work. Twelve students admitted in September 1997 have completed the first semester

Cochin University of Science & Technology. Another candidate who had registered with this University completed

of their course work and commenced the second semester offering specialization on identified subjects.

Krishi Vigyan Kendra

The following training programmes were conducted during the year

No.	Subject	Duration in days	No. of courses conducted	Trainees		
				Male	Female	Total
A. FISHERIES						
1.	Prawn farming	15	2	-	51	51
2.	Prawn farming	5	6	50	58	108
3.	Mussel farming	2	2	22	15	37
4.	Prawn seed collection methods	2	1	17	-	17
B. AGRICULTURE						
1.	Coconut cultivation	3	1	-	22	22
2.	Coconut cultivation	2	2	20	20	40
3.	Mushroom cultivation	3	1	20	10	30
4.	Mushroom cultivation	2	3	9	53	62
5.	Mushroom cultivation	1	2	78	32	110
6.	Vegetable cultivation	2	1	-	20	20
7.	Vegetable cultivation	1	1	2	23	25
C. HOME SCIENCE						
1.	Health and Hygiene	1	1	2	23	25
TOTAL			23	220	327	547

Trainers' Training Centre

During 1997, the Trainers' Training Centre in collaboration with scientists of the Institute conducted 10 short term training courses based on the expertise available at the Institute. The courses were conducted at Tuticorin, Mandapam and Cochin. The details are as given below:



Shri G. P. Kumarasamy Achari demonstrating the "off bottom culture cage" to the trainees of the KVK sponsored training on Pearl culture conducted during 16-31 March, 1998 at TRC of CMFRI



Shri. T. K. Ramakrishnan, Hon. Minister for Fisheries, Govt. of Kerala, delivering the inaugural address at TTC training course on 'Ornamental Fish culture' held at Vizhinjam Research Centre of CMFRI

Sl. No.	Title of the course	Duration	No. of courses conducted	No. of participants
1.	Hatchery production of marine prawn seeds	20.1.97 to 1.2.97 (12 days)	1	5
2.	Seaweed culture and utilisation	17.2.97 to 27.2.97, 19.5.97 to 29.5.97 (10 days each)	2	10+16
3.	Edible oyster culture	11.3.97 to 21.3.97 (10 days)	1	2
4.	Postharvest technology	17.3.97 to 27.3.97 (10 days)	1	5
5.	Marine pearl culture	7.4.97 to 3.5.97 (27 days)	1	7
6.	Mussel culture	28.7.97 to 29.7.97 (2 days)	1	32
7.	Transportation of live finfish & shellfish	13.10.97 to 18.10.97 (6 days)	1	4
8.	Live feed culture (6 days)	24.11.97 to 29.11.97	1	13
9.	Computer application in stock assessment of marine fishes	1.12.97 to 23.12.97 (23 days)	1	8

Dr. M. Devaraj Director CMFRI showing the Marine aquarium to the distinguished visitors Dr. B. Vasanthidevi V. C. M. S. University, Tamilnadu and Dr. B. S. Hansra ADG, ICAR, TTC



Participants of the TTC training course on Mudcrab farming interacting with a farmer

A total of 102 participants from the States of Kerala, Tamilnadu, Andhra Pradesh, Karnataka, Gujarat, Orissa, Maharashtra including the U.T. of Pondicherry and Andaman & Nicobar Islands attended the course.

Other Training Programmes

A workshop-cum-training programme was conducted on 10.6.1997 at Kasargode to the women groups on the harvesting, shucking and marketing of mussels.

A workshop on mussel farming was organised on 10-6-1997 at Kasargode for the district extension workers, representatives of the Panchayat bodies to make them aware on the technology.

Training on mussel farming was given to 45 women of 3 groups in Kasargode on 3.10.1997.

Training was given to the farming groups in Kasargode in their fields on 3.10.97, 28.11.97 on the technology of mussel farming.

A one-month training on nucleus implantation and pearl production was given to 17 local women volunteers at Tuticorin Research Centre.

AWARDS AND RECOGNITIONS

An all India Aquarium Show and Exhibition was conducted by the Department of Fisheries, Govt. of Kerala, Kerala State Co-operative Federation for Fisheries Development at Kanakakunnu Palace, Thiruvananthapuram from 6th to 11th January 1998. The CMFRI stall was awarded the *FIRST* prize and trophies for the Best Stall, Best Institutional Stall and also

the Fisheries Minister's Trophy for the Best Institution.

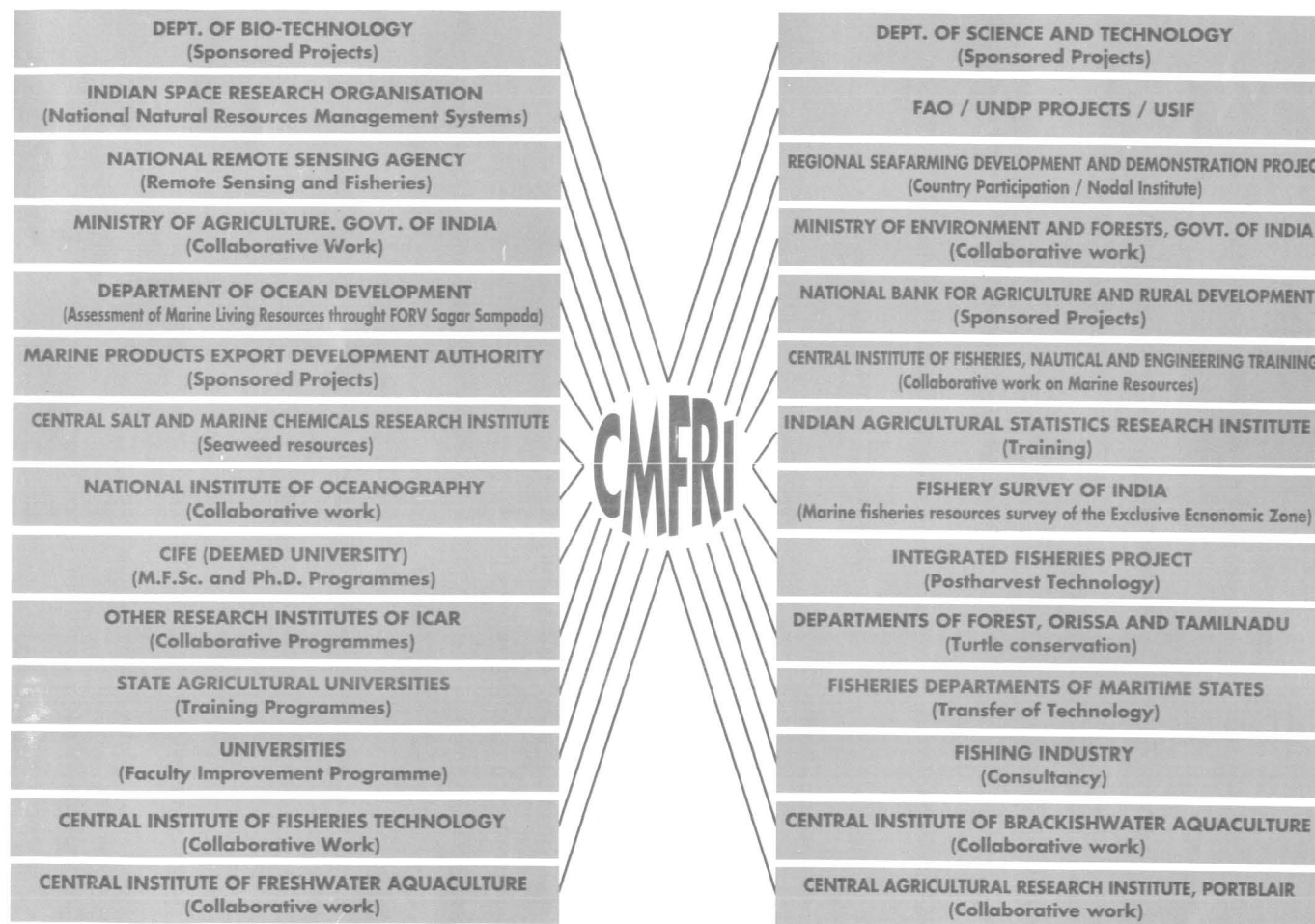
The Institute won the rolling trophy from the Cochin TOLIC for excellent Hindi Implementation programme for the year 1996-97 and the Joint Hindi Week celebrations for the excellent performance in Hindi competitions.



Shri E. K. Nayanar, Chief Minister Kerala, handing over the Fisheries Minister's Trophy for the Best Institutional stall to CMFRI at the All India Aquarium show and exhibition

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, COCHIN (ICAR)

LINKAGES



LINKAGES AND COLLABORATION IN INDIA AND ABROAD INCLUDING EXTERNALLY FUNDED PROJECTS

FUNDING BY FOREIGN AGENCIES

Projects under consideration

1. Multispecies Marine Fish Stock Enhancement along the Southern Coast of India, (US\$ 3.9 million) ,SARDI, Australia
2. Evaluation of species identify and genetic polymorphisms in sand whittings (Pisces/ Percoidei/Sillaginidae) for conservation and management (US\$ 12,000) IFS, Sweden

Projects under operation

1. Carcinogenic and mutagenic contaminants in the coastal environment : Bioeffect monitoring through mussel watch (US\$ 10,000) IFS, Sweden
2. Effect of probiotic feeding in the rearing and production of marine shrimp larvae US\$ 12,000 IFS, Sweden

FUNDING BY INDIAN AGENCIES

Projects under operation

1. Tissue culture of some economically important seaweeds by AP Cess Fund of ICAR
2. Commercial propagation of marine pearl culture technology by DOD
3. Commercial production of cultured pearls adopting onshore culture technology by ICAR Revolving Fund
4. Genetic manipulation of seaweeds by cell culture and somatic hybridisation by DBT
5. Studies on the defence mechanisms and host-pathogen interactions in bacterial and viral diseases of crustaceans and bivalves by AP Cess Fund of ICAR
6. Cultivation of agar yielding seaweeds under green house condition by DBT
7. Studies on mangrove ecosystem of Gulf of Mannar Islands and their impact of larval recruitment of economically useful fishes and prawns by MoE&F
8. Studies on the biology and sea ranching of the sacred chank, *Xancus pyrum* with special reference to the protection of species in the marine national park of Gulf of Mannar by MoE&F
9. Hatchery production of clam, *Meretrix* sp. seed by DBT
10. Tissue culture in pearl oyster by DBT
11. Hatchery production of the green mussel, *Perna viridis* seed by DBT
12. Induction of triploidy in commercially important bivalves by AP Cess Fund of ICAR
13. Stock assessment and resource mapping of deep sea fishery resources in the Indian EEZ by DOD
14. Studies on the DSL by DOD
15. Investigations on the toxic algal blooms in the EEZ of India by DOD

LIST OF PUBLICATIONS

(only those actually published during the year)

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- ARAVINDAKSHAN, M. AND JOHNY DIAS 1997. A neptunid shrimp in trawl catches at Sasson Dock, Mumbai. *Fishing Chimes*, 17(2): 43.
- ARAVINDAKSHAN, M. 1997. Occurrence of Dorodotes shrimp off Mumbai coast. *Fishing Chimes*, 17(7): 29.
- ARAVINDAKSHAN, M. 1997. Fishing trends of two mudshrimps off Mumbai Coast. *Fishing Chimes*, 17(8): 54.
- BADRUDEEN, M. AND P.K. MAHADEVAN PILLAI. 1997. Food and feeding habits of the big-eyed mojarra, *Gerres macracanthus* Bleeker of the Palk Bay and the Gulf of Mannar. *J. mar. biol. Ass. India*, 38 (1 & 2): 58-62 (1996).
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CONSULTANCY, PATENTS, COMMERCIALISATION OF TECHNOLOGY

<i>Client</i>	<i>Amount (Rs)</i>	<i>Type of projects</i>
Projects completed during 1997-98		
1. Mangalore Refinery & Petrochemicals Ltd., Mangalore	3,60,000	Consultancy
2. SPIC Electric Power Corporation, Tuticorin	36,000	Contract Research
3. Mangalore Refinery & Petrochemicals Ltd., Mangalore	89,000	Contract Research
TOTAL	4,85,000	
Ongoing Projects - 1997-98		
1. Mangalore Refinery & Petrochemicals Ltd., Mangalore	3,60,000	Consultancy
2. Kudermukh Iron Ore Company Ltd., Kudermukh	3,80,000	Consultancy
3. CARE-India, Bombay	3,30,000	Consultancy
4. Indian Tropical Agro- Products, Tuticorin	1,50,000	Consultancy
5. Hardy Exploration and Production India (inc.), Chennai	9,60,800	Consulancy
6. NEERI Nagpur	4,59,000	Contract Research
Approved Projects		
7. Cochin Port Trust, Cochin	4,01,000	Consultancy
8. Sujana Steels Ltd., Hyderabad	1,07,000	Contract Research
TOTAL	31,47,800	
120		

RESEARCH ADVISORY COMMITTEE, MANAGEMENT COMMITTEE AND STAFF RESEARCH COUNCIL MEETINGS

The **RAC meeting** was held on 22.12.1997 at the Vizhinjam Research Centre of the Institute under the Chairmanship of Prof. N. Balakrishnan Nair with Dr. D. Sudarsan, Dr. P. Natarajan, Dr. Arun Parulekar, Dr. M. Devaraj and Dr. R.A. Selvakumar as members. Dr. P.S.B.R. James, Shri Choudhary G.S. Dharasingh, and Engr. Nathu Lal Gujar could not attend this meeting. The R&D programmes carried out by the CMFRI were reviewed and the Chairman expressed great appreciation for the achievements in the ongoing programmes. The Committee suggested that emphasis needs to be given to the undermentioned areas in the programmes of the Institute:

- human resources development for the R&D activities in marine fisheries
- development of database on exploited stocks by increasing the sampling coverage
- development of database on deepsea resources
- development of prediction models for marine fish catch
- development of alternate materials for making rafts, cages, anchoring the rafts and other struc-

tures, in conducting pearl culture in the open sea by consulting organisations like IIT Chennai, NIO Goa, CIFT Cochin and other institutions

- preparation of status report on marine biodiversity in India

The Management Committee Meetings were held on 3-7-1997 and 23.3.1998 and the following approvals were accorded:

- Construction of 4 residential quarters for CMFRI staff at Calicut (Phase II),
- Construction of hatchery and culture laboratory at the harbour site near inspection Bungalow at the Vizhinjam Research Centre of CMFRI, Vizhinjam
- Construction of Hostel for CMFRI at Cochin

The SRC meeting of the Institute was held on 24-4-1997. Discussed the progress of ongoing projects and finalised the research projects of the Institute for the years 1997-2002.

PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS AND SYMPOSIA IN INDIA AND ABROAD AND FOREIGN TRAINING

Name & Designation	Particulars	Date/s
Dr. M. Devaraj Director	Discussion with Secretary (Fisheries) Govt. of Kerala on the acquisition of land for the Centre for Development and Transfer of Mariculture Technologies (CDTMT), Trivandrum	April 11, 1997
	Asia-Pacific Fisheries Commission (APFIC) Working Party on marine fisheries at Bangkok, Thailand	May 13-16, 1997
	Meeting convened by the Chief Secretary, Govt. of Kerala on the report of the Expert Committee on the Ocean Part of the Coastal Zone at Secretariat, Trivandrum	May 27, 1997
	Seminar on public awareness on the science of environmental changes organised by Kanyakumari District Science Association and delivered a talk on fishing along the Indian coastline, Kanyakumari	June 27-28, 1997
	ACIAR-ICAR Interface meeting followed by group discussions and plenary sessions, New Delhi	July 10, 1997
	Workshop regarding academic and other issues relating to UG and PG education, CIFE, Mumbai	July 14-15, 1997
	52nd meeting of projects screening committee/scientific panel for fisheries, New Delhi	August 5-6, 1997
	Seminar on fluctuations in marine fishery resource availability, jointly organised by Kerala Fisheries Society and CMFRI, Trivandrum	August 20, 1997
	Task Force meeting on CRI of the Science and Technology and Environment Department, Trivandrum D	August 20, 1997

Dr. M. Devaraj Director	Discussion with Fr. Mariadasan, Executive Director, Kerala Social Service Society regarding implementation of the NATP project programmes and visit to the project site, Kottar	August 21-22, 1997
	XXII meeting of the Academic Council of CIFE, Mumbai	August 30, 1997
	Divisional meeting of all the Fisheries Research Institutes under the chairman- ship of the DDG Fisheries, ICAR, to review the IX Plan proposals of the Institutes, Calcutta	September 19-20, 1997
	CDTMT Management Committee Meeting in the Office of the Director of Fisheries, Kerala, Thiruvananthapuram	November 29, 1997
	Meeting with the Hon'ble Minister for Fisheries, Govt. of Kerala regarding Fisheries Resource Management	December 1, 1997
	Meeting of the Institute Research Advisory Committee at Vizhinjam Research Centre	December 22, 1997
	Delivered the inaugural address and participated in the Integrated Coastal Management Workshop of Manonmanian Sunderanar University at Nagercoil	December 30-31, 1997
	National Aquaculture Seminar at Kanakakunnu Palace, Trivandrum and delivered keynote address	January 8, 1998
	Social Service Society Meetings at Trivandrum (Poovar), Kottar and Tuticorin for identifying target groups of fishermen under the DOD project on pearl culture	January 9-11, 1998
	Seminar on Recent Developments in Pearl Culture, Grouper and Crab farming at Mandapam Camp	February 6-7, 1998
	Workshop on the coastal Biodiversity of Gulf of Mannar and delivered the keynote address at M.S. Swaminathan Research Foundation, Chennai	February 10, 1998
	Meeting of the key stake holders on research, monitoring and evaluation of Gulf of Mannar Biosphere Reserve	February 18, 1998

	Meeting of the Kerala State Fisheries Management Committee to decide the approval of the Kerala Government sponsored R&D project on Marine Ornamental Fishery to CMFRI and to discuss the revised Indo-Australian Project on Stock Assessment with the Hon'ble Minister for Fisheries, Govt. of Kerala	March 1-3, 1998
	ICAR Director's Conference at New Delhi Executive Committee meeting of the	March 4-5, 1998
	Asian Fisheries Society meeting at Mangalore	March 14, 1998
	Valedictory function of the TTC Ornamental Fish Culture Training Programme with the ADG (Extn) at Vizhinjam Research Centre	March 21, 1998
	49th meeting of the Management Committee of the Institute at Vizhinjam	March 23, 1998
Dr. G. Sudhakara Rao Head, CFD	Annual meeting of the Kerala Fisheries Society at Trivandrum	August 20, 1997
	Colloquium on key issues relating to the fisheries sector organised by MPEDA at Cochin	October 14-15, 1997
	13th meeting of the Consultative Group Cochin Base of Fishery Survey of India at Cochin	December 11, 1997
	Symposium on Advances and priorities in Fisheries Technology organised by Society of Fisheries Technologists, CIFT, Cochin	February 11-13, 1998
Dr. V. Sriramachandra Murty, Head, DFD	"Maneka's Ark" A Television Programme on Aquarium fishes, New Delhi	April 16, 1997.
	Workshop on "Turtle Excluder Devices" sponsored by MPEDA and National Marine Fisheries Service of the U.S.A., at IFP, Cochin	May 5, 1997
	First meeting of the Technical group on Capacity Building in Taxonomy, Ministry of Environment and Forests, New Delhi	July 22, 1997
	Meeting of National Programme of FORV <i>Sagar Sampada</i> on Assessment of Marine Living Resources in the Indian EEZ - IFP Cochin	August 20, 1997
	Colloquium on Key Issues relating to the Fisheries Sector, MPEDA, Cochin	October 14-15, 1997.

Dr.K.K.Appukuttan Head, MFD	Meeting of the Core group on All India coordinated project on taxonomy, Ministry of Environment and Forests, New Delhi	October 16, 1997
	Meeting of the Working group to study the draft proposal for the All India coordinated project on coastal and marine biodiversity, NIO, Goa	October 27, 1997
	Second meeting of the Technical group on Capacity Building in Taxonomy, Ministry of Environment and Forests, New Delhi	October 28, 1997
	Meeting of the Task Force of the DOD on " Stock Assessment, Biology and resource mapping of deepsea resources in the Indian EEZ". CUSAT, Cochin	December 10-11, 1997
	First Meeting of the <i>Sagar Sampada</i> Scientific Advisory Committee. Onboard FORV <i>Sagar Sampada</i> , Cochin	December 12, 1997
	Meeting of the Key Stake Holders on Research, Monitoring and Evaluation of Gulf of Mannar Biosphere Reserve. M.S. Swaminathan Research Foundation, Chennai	February 18, 1998
	Meeting of the Task Force of the DCD on "Stock Assessment, Biology and resource mapping of deepsea resources in the Indian EEZ". FSI, Mumbai	March 2, 1998
	Third Meeting of the Technical group on Capacity Building in Taxonomy. Ministry of Environment and Forests, New Delhi	March 10, 1998
	Meeting organised by Kerala State Government on the occasion of formulation of policies for 'Janakiya Matsyakrishi' - A scheme for fish culture under the Chairmanship of Hon'ble Minister of Fisheries, Shri T.K. Ramakrishnan	January 4, 1997
	Meeting organised by State Fisheries Department for the inauguration of District level training programme on aquaculture for farmers in connection with Janakiya Matsyakrishi at Co-operative Bank Conference Hall	February 28, 1997
	Function organised by the Kerala Inland Fish Farmers' Association, Kollam in connection with the inauguration of oyster farming training at Kollam financed by Kerala	March 20, 1997

State Small-scale Industries Department at Kollam Co-operative Bank auditorium	
Special lecture on Recent advances in Molluscan aquaculture in India for the participants of training programme on Recent advances in Aquaculture organised by Fisheries Departement Karnataka and Fisheries Colleges, Mangalore at Mangalore Fisheries College	February 12, 1997
Farmers meet at Narakkal organised by CMFRI. Gave a talk on integrated farming - especially on molluscs in Malayalam at KVK, Narakkal	April 5, 1997
Talk on recent advances in molluscan aquaculture to PG Diploma students of Sacred Heart College, Thevara, Cochin at CMFRI, Cochin Women labourers Day celebration jointly organised by CMFRI & CIFT. Presided over the function	April 4, 1997
M.Phil Viva voce for candidates from Dept. of Aquatic Biology & Fisheries, Trivandrum (University of Kerala)	April 29, 1997
The Golden Jubilee workshop on Deep sea resources organised by FSI, Cochin Zonal Office and gave a talk on Deep sea fishery resources and prospects of increased production at Kollam, Co-operative Bank Conference Hall	May 8, 1997
NATP Fine tuning workshop in CIFT, Cochin.	May 23-28, 1997
Farmers meet at Kadamakudi. Presided over the function.	May 30, 1997
Steering Committee meeting of District Committee of Janakiya Matsyakrishi at Kollam	May 31, 1997
Discussion with Dr.Muthunayagam, Secretary, DOD at Chavara on pearl culture programme	June 20, 1997
NATP workshop & presentation of project proposal	June 23, 1997

	Radio talk at All India Radio, Trichur under Farm School on AIR programme and further question & answers	August 23-28, 1997
Shri T.S.Velayudhan Sr. Scientist	Represented CMFRI in the meeting held at Trivandrum Secretariat by the Hon'ble Minister for Fisheries Shri T.K. Ramakrishnan on the location of formulation of policies for 'Janakeeya Matsyakrishi'	January 4, 1997
	Scheme on fish culture Represented CMFRI in 'Colloquim on key issues on 'Fishing and Aquaculture' organised by MPEDA, Cochin	October 14-15, 1997
	Talk on pearl culture to Councillors, staff of BFFDA, and MATSYAFED at Quilon Municipality office, Quilon	June 18, 1997
	Conducted two days training programme on mussel farming to the 25 selected farmers by the Orumanayoor and Kadappuram Panchayats of Thrissur District, at Chettuva	December 3-4, 1997
	Interview on pearl culture at AIR, Thrissur	March 1, 1997
	Talk on 'Marine Pearl culture in India' at AIR, Thrissur and further question answers	September 17, 1997 & October 12, 1997
Dr.K. Sunilkumar Mohamed Scientist (Sr.Scale)	Talk on Mussel culture prospects to Kollam Muncipal Councillors at Kollam Municipality	June 18, 1997
	Colloquium on key issues in Fishing and Aquaculture organised by MPEDA	October 14-15, 1997
	NATP Orientation Workshop at Madras Veterinary College	October 27, 1997
Smt.V. Kripa, Scientist (Sr. scale)	Imparted training the oyster farming to fishermen at Quilon-Training organised by Kerala Inland Fish Farmers Association and Kerala State Small-scale Industries Department.	March 22, 1997
	Training and demonstration on mussel culture to fishermen of Narakkal organised by KVK, Narakkal	March 25-26, 1997

	Talk on prospects of oyster farming to BFFDA and Matsyafed at Kollam Municipality Hall as a part of Janakeeya Matsya Krishi programme.	June 18, 1997
	Talk on oyster farming to entrepreneurs of Kadamakudi Panchayat as a part of Fishermen Meet organised by SEETTD Division	May 30, 1997
	Training conducted and demonstration programme on mussel farming to selected farmers at Orumanayoor and Kadappuram Panchayats of Thrissur District at Chettuva.	December 3-4, 1997
	Talk on 'Pearl Culture Prospects, the Export Development Seminar conducted by Organisation of Awakened Society for Integrated Service (OASIS) at Coimbatore.	July 13, 1997
Dr.P. Laxmilatha Scientist	Training and demonstration on "Mussel culture" for 40 fishermen of Narakkal at KVK, Narakkal	March 3-4, 1997
	Mussel harvest at Chettuva	June 5, 1997
	Regional Training Course in Fishing Technology and Resource Conservation Conservation, at the Training Department, Southeast Asian Fisheries Development Center, (SEAFDEC), Samut Prakan, Thailand.	June 16, 1997 to December 15, 1997
Dr. N.G.K. Pillai Head, PFD	Workshop on Turtle Excluder Devices organised by Marine Products Export Development Authority in association with the National Marine Fisheries Service (USA), Cochin	May 5-6, 1997
	Task Force Meeting on "Harvest Technology and catch composition of deep sea fishery resources of Indian EEZ" organised by Central Institute of Fisheries Technology, Cochin	March 2, 1997
	National Programme on Assessment of Marine Living Resources in the Indian EEZ organised by Dept. of Ocean Development, New Delhi at Cochin	August 20, 1997

Dr. N.G.K. Pillai Dr. P.P. Pillai Shri A.A. Jayaprakash Dr. P.N.R. Nair	Indo-Egyptian Workshop on Oceanography with exclusive focus on mariculture at CMFRI, Cochin in collaboration with the Dept. of Science & Technology, New Delhi	December 8-9, 1997
	Changing Scenario in Marine Fisheries Research and New Dimensions (in Hindi) at CMFRI, Cochin	March 3, 1998
Dr. N.G.K. Pillai Dr. P.P. Pillai	Symposium on Advances and Priorities in Fisheries Technology organised by Society of Fisheries Technologists and Central Institute of Fisheries Technology, Cochin	February 11-13, 1998
Dr. M. Srinath Sr. Scientist	Meeting of coordinators of NOIS and MARSIS held at DOD, New Delhi	February 20, 1997
	Workshop on Ocean Information Management held at NIO, Goa	September 17-19, 1997
	Interdisciplinary workshop on Bio-Statistics at Manonmaniam Sundaranar University, Thirunelveli	March 20-21, 1997
Dr. M. Srinath Dr. K.S. Scariah Shri K. Balan Shri K.N. Kurup Dr. R. Venugopalan	Seminar on Fluctuation in fish availability in Kerala coast - factors contributing to Kerala Fisheries Society, Trivandrum	August 20, 1997
Dr. M. Srinath Shri K.N. Kurup Shri K. Balan	Colloquium on key issues relating to the fisheries sector, MPEDA. Cochin	October 14-15, 1997
Dr. K.S. Scariah Dr. R. Venugopalan	Computer training for ARIS personnel at UAS, Bangalore	September 4-13, 1997
Dr. R. Sathiadhas Sr. Scientist	NATP workshop at Tamil Nadu Veterinary and Animal Science University, Chennai	October 27, 1997
	National Seminar on Coastal Zone Management, Sundaranar University	December 30-31, 1997
Smt. Sheela Immanuel Scientist	National Seminar on The Technological Empowerment of Women in Agriculture organised by National Commission for Women and M.S. Swaminathan Research Foundation at Chennai	December 3-4, 1997

Dr. A. Laxminarayana Sr. Scientist	Radio talk on Mud Crab Farming	April 23, 1997
	Talk on 'Induced maturation of penaeid shrimps in captivity' at MES Asmabi College, Kodungalloor	November 1, 1997
	Seminar on Innovative Technologies organised by NABARD at Mangalore	January 5, 1998
Dr. C. Suseelan Sr. Scientist	XXII meeting of the Academic Council of the Central Institute of Fisheries Education (Deemed University), Mumbai	April 11, 1997
	Workshop convened by the Department of Education, ICAR, at CIFE, Mumbai to review the syllabi of B.F.Sc. degree offered by the SAU and other matters connected with fisheries education	July 14-15, 1997
	Seminar on "Fluctuations in fish availability in Kerala coast - Factors contributing to" convened by the Kerala Fisheries Society at the Mannam Memorial National Club Hall, Thiruvananthapuram	August 20, 1997
	Meeting convened by the Hon'ble Minister of Fisheries, Govt. of Kerala at Govt. Guest House, Kottayam to discuss about the proposed Indi-Australia research project on "Multispecies marine fish stock enhancement along the southern coast of India" with experts from CMFRI and the South-Australian Research and Development Institute (SARDI)	September 14, 1997
Dr. Manpal Sridhar Scientist (SS)	Symposium on Advances and Priorities in Fisheries Technology held at CIFT, Cochin	February 11-13, 1998
	Indo-Egyptian Workshop on Oceanography with exclusive focus on mariculture at CMFRI, Cochin	December 8-9, 1997
	Hindi Scientific Seminar on Changing Scenario in Marine Fisheries Research and New Dimensions at CMFRI, Cochin	March 3, 1998
Dr. N. Sridhar Scientist (SS)	Deputed to USA for undergoing Dept. of Biotechnology Overseas Associateship under Dr. Milton Fingerman at the Department of Ecology, Environment and Organismal Biology, Tulane University, Louisiana, USA	February 10, 1997 to August 10, 1997

Dr. Kuber Vidyasagar Sr. Scientist	27th Consultative Group Meeting at Fishery Survey of India, Mumbai	April 4, 1997
	Academic Council Meeting at Dapoli	May 9, 1997
	Fifty Years of Independence - 1947-97 and Golden Jubilee Celebrations of Fishery Survey of India, Mumbai Base organised Open House on Board the fishery resources survey vessel Matsya Nireekshani	September 4, 1997
	Meeting regarding 'Shrimp farming in the country with special reference to CRZ regulations' of High level delegation lead by Hon'ble Union Minister of Agriculture (State) at Mumbai	July 10, 1997
	National Seminar organised by Central Institute of Fisheries Education on 'Vision on Indian Fisheries of 21st Century'	February 7-8, 1998
Dr. V.V. Singh Scientist (SS)	Working Group Meeting for Development of Curriculum (Environment) in the area of agriculture at PSS CIVE (NCERT), Bhopal	May 12, 1997
	National Seminar organised by Central Institute of Fisheries Education on 'Vision on Indian Fisheries of 21st Century'	February 7-8, 1998
	Tutorial-cum-Workshop on IRS-P3 MOS Data handling and Utilization and actively interacted with the faculty during technical and interactive Sessions at Space Applications Centre, Ahmedabad	February 11-13, 1998
Shri M.Z. Khan, Sr. Scientist Ms. Arpita Sharma Scientist	National Seminar organised by Central Institute of Fisheries Education on 'Vision on Indian Fisheries of 21st Century'	February 7-8, 1998
Ms. Arpita Sharma Scientist	National Workshop on New economic policy, challenges, opportunities for sustainable development of fisheries and conservation of aquatic resources in rural areas at Bhopal	December 15-16, 1997
Shri D.C.V. Easterson Sr. Scientist	Brain Storming Session for evolving a suitable methodology to quantify the resources of R&D in Science and Technology including manpower in	October 13-14, 1997

	academic sector at Industries and Earth Sciences Department, Tamil University, Tanjore	
	Served as a member in the UGC Evaluation Committee on Industrial Fisheries Course being conducted at Kamaraj College, Tuticorin	November 11, 1997
	Served as Chairman of the Interview Committee constituted for the recruitment of Project staff by Offshore Platform and Marine Electrochemistry Centre, CECRI, Tuticorin	November 26, 1997
	Discussions on the conservation of Gulf of Mannar Marine Biosphere Reserve held at Fisheries College and Research Institute, Tuticorin organised by M.S. Swaminathan Research Foundation, Chennai	December 3, 1997
	National Seminar on Coastal Zone Management organised by the Institute for Coastal Area Studies, MS University at Nagercoil	December 30-31, 1997
	Workshop on Coastal Biodiversity of Gulf of Mannar conducted by M.S. Swaminathan Research Foundation, Chennai	February 10-11, 1998
Dr. D.B. James Sr. Scientist	Lecture on hatchery and culture of seacucumbers at Centre of Coastal Aquaculture and Marine Biotechnology, Dept. of Marine Living Resources, Andhra University	July 11, 1997
	Lecture on "Biotoxicity in echinoderms" at the National Symposium on "Recent Developments in Natural Products" organised by the Department of Chemistry, Andhra University	July 12, 1997
	Lecture on Resources, Processing, Hatchery and Culture of sea cucumbers for M.Sc. Agriculture students at Govt. Arts College, Nandanam	July 14, 1997
	Lecture on seacucumber culture and seed production at the Indo Egyptian Workshop on Oceanography with exclusive focus on mariculture	December 9, 1997

	at CMFRI, Kochi	
	Workshop on Coastal Biodiversity of Gulf of Mannar organised by the M.S. Swaminathan Research Foundation, Chennai	February 10, 1998
	Seminar on Human Resources Development in Fisheries Sector in Tamil Nadu organised by the Fisheries Technocrats forum, Chennai	February 14, 1998
S/Shri A. Chellam, K. Ramadoss, P. Muthiah, V.S. Rengasamy, D. Ssivalingam, S. Natarajan and Dr. H.M. Kasim	Seminar on Recent Developments on Pearl culture, Groupers Grouper and Crab farming held at Mandapam Regional Centre	February 6-7, 1998
Shri A. Chellam, Sr. Scientist	Seminar on Export Development conducted by OASIS at Trichy	March 15, 1998
Dr. P. Muthiah, Sr. Scientist Shri S. Dharmaraj Sr. Scientist	Indo-Egyptian Workshop at CMFRI, Kochi	December 8-9, 1997
Dr. A.C.C. Victor, Dr. N. Kaliaperumal, Shri. A. Raju, Shri. D. Kandasamy (Senior Scientists), Dr. G. Maheswarudu (Scientist Senior Scale), Smt. Josileen Jose and Shri. I. Jagadish (Scientists)	Workshop on National Aquaculture Week at Mandapam Camp	February 5-7, 1997
Dr. A.C.C. Victor, Dr. N. Kaliaperumal, Senior Scientists and Dr. G. Maheswarudu, Scientist (Senior Scale)	Indo-Egyptian Workshop on Oceanography with exclusive focus on mariculture at CMFRI, Cochin	December 8-9, 1997
Dr. A.C.C. Victor, Sr. Scientist, Dr. N. Kaliaperumal, Shri. A. Raju, Shri. D. Kandasamy (Senior Scientists), I. Rajendran, Scientist (Senior Scale),	Seminar on "Recent development in pearl culture, grouper and crab farming" at Mandapam Camp	February 6-7, 1998

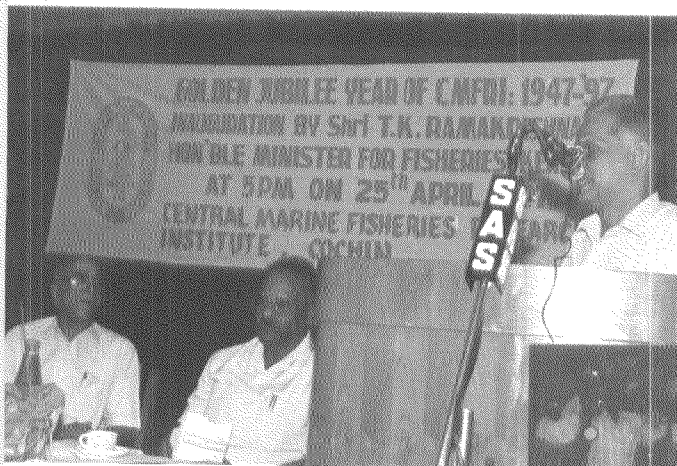
I. Jagadish, Boby Ignatius, Gaurav Rathore and Smt. Rekha J. Nair, Scientists	Seminar on "Recent developments in pearl culture, grouper and crab farming" at Mandapam Camp	February 6-7, 1998
Dr. A.C.C.Victor, Sr. Scientist	Seminar on National Aquaculture Week at Tuticorin	June 12, 1997
Dr. N. Kaliaperumal Sr. Scientist	National Symposium on "Recent trends in Algal research organised by the Department of Botany, Andhra University, Visakapatnam	March 6-8, 1997
	"Industries get together" organised by CECRI, at Mandapam Camp	November 28, 1997
	Workshop on "Coastal Biodiversity of Gulf of Mannar" organised by M.S.Swaminathan Research Foundation at Chennai	February 10-11, 1998
Shri. I. Jagadish, Scientist	Training on finfish breeding and hatchery management at Central Institute of Freshwater Aquaculture, Bhuvaneswar	May 8-20, 1997
Shri. A. Raju, Senior Scientist, I. Rajendran, Scientist (Senior Scale) I. Jagadish, Scientist Smt. Rekha J. Nair Scientist	Training programme on seabass breeding and hatchery techniques at Central Institute of Brackishwater Aquaculture, Chennai	September 10-20, 1997
	Training course on "Computer Application in stock assessment of marine fishes" at CMFRI, Cochin	December 1-23, 1997
Smt. Rekha J. Nair, Scientist	Symposium on "Advances and Priorities in Fisheries Technology" at CIFT, Cochin	February 11-13, 1998
Dr.V.S.K.Chennubhotla Principal Scientist	Workshop on Development of Marine Fisheries in Andhra Pradesh organised by Action for Food Production (AFPRO) in Hyderabad	June 27-28, 1997
	Chaired a session in the International Seminar on Eco- forestation, Biodiversity, Conservation & Sustainable Development organised by the International Environmental Research Academy, Visakhapatnam and the International Socio-Environmental Awareness Studies Centre, Bangalore at Bangalore	December 6-7, 1997

Dr.V.S.K.Chennubhotla, Dr.K.Satyanarayana Rao, Principal Scientists	National Symposium on Coastal and Estuarine Processes around India organised by Chemical Oceanography Department of P.N.C.O., School of Chemistry, Andhra University, Visakhapatnam at Visakhapatnam	September 10-11, 1997
	Zonal Workshop of the Field Staff of Fisheries Resources Assessment Division at Kakinada Research Centre of CMFRI	September 24-27, 1997
Dr.V.S.K.Chennubhotla, Dr.K.Satyanarayana Rao, Principal Scientists and Dr. G. Syda Rao, Sr. Scientist	National Workshop on Coastal marine culture systems organised by Dept. of Ocean Development at Andhra University	February 16-17, 1998
Shri K.Prabhakaran Nair Sr. Scientist	Workshop on variation in Marine Fish Production in Kerala organised by Kerala Fisheries Society, Thiruvananthapuram	August 20, 1997
	National Seminar on Coastal Zone Management organised by the Institute of Coastal Area Studies, Manonmaniam Sundarnar University, Nagercoil	
S. Krishna Pillai Sr. Scientist	National Seminar on Coastal Zone Management organised by Manonmaniam Sundarnar University, Institute for Coastal Area Studies, S.C. College Campus, Nagercoil	December 30-31, 1997
	Workshop on Conservation and Management of Fishery Resources of Kerala, Fisheries Resources Management Society, Kerala	January 7-9, 1998
Shri M. Sivadas Scientist (SS)	Symposium on Advances & Priorities in Fisheries Technology conducted at CIFT, Cochin	February 11-13, 1998
Dr. B. Manojkumar Scientist	Meeting convened by the Secretary, Port and Fisheries, Gujarat State at Gandhinagar in connection with the EEC ban on the export of marine products	February 9, 1998
Shri G. Subbaraju Principal Scientist	Kisan mela by Andhra Pradesh Agricultural University, Kakinada	November 28-29, 1997
	Seminar on Electrolytic Gas generator & its applications in Aquaculture by M/s Victory Water Technologies, Hyderabad at Kakinada	December 7, 1997

	Farmer's meet on Sustainable shrimp farming by MPEDA, Vijayawada, Kakinada	January 23, 1998
	Workshop on strategy planning for Post-Harvest Fisheries in Andhra Pradesh by D F I D Post-Harvest Fisheries Project, at Kakinada	December 29-30, 1998
Dr. P.S. Kuriakose Principal Scientist and Dr. E.V. Radhakrishnan Sr. Scientist	Seminar on Indo-Egyptian Workshop on mariculture technologies at CMFRI, Kochi	December 8-9, 1997
Dr. T.M. Yohannan Sr. Scientist	Seminar on coastal area management under the Institute for Coastal area studies in Nagarkoil	December 30, 1997
Shri K. Dorairaj Principal Scientist	Seminar on 'Safety at Sea' at BOBP at Chennai	May 16, 1997
	GIS project Meeting at DOD Anna University at Chennai	July 22, 1997
	Working group Meeting to finalize IX Plan Scheme of Tamil Nadu Fisheries Dept. at Chennai.	August 8, 1997
	First and Second Steering Committee Meetings of GOI/ UNDP/GEF Project for strengthening the Management of Gulf of Mannar Marine Biosphere Reserve (GOMMBR) at MSSRF, Chennai	October 9, 1997 and December 16, 1997
	First and Second Task Force Meetings on GOI/UNDP/GEF Project on GOMMBR at Chennai and Mandapam Camp.	November 3, 1997 and December 1, 1997
	Workshop on Curriculum Development in Ecotechnology at MSSRF, Chennai	November 26-27, 1997
	GOMMBR Meeting & NGO Consultancy at Tuticorin	December 3, 1997
	Regional Workshop on the Conservation and sustainable Management of coral reefs organised by MSSRF and BOBP at Chennai	December 15-17, 1997
	Stakeholders Meeting on GOMMBR at MSSRF at Chennai	February 18, 1998

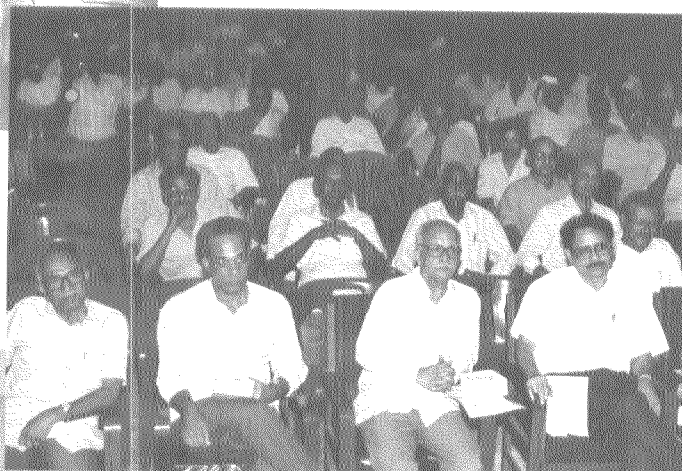
Shri K. Dorairaj Dr. R. Paul Raj Dr. E. Vivekanandan Dr.M. Rajagopalan	Meeting with 9 Member Parliamentary Delegation led by Hon'ble Minister of State, Agriculture, on Aquaculture Bill 1997 at Veterinary University, Chennai	July 1, 1997
Shri K. Dorairaj Dr. R. Paul Raj Dr. E. Vivekanandan	BOBP Coastal Fisheries Management Project - Review Meeting at Chennai	August 19, 1997
Shri K. Dorairaj Dr. R. Paul Raj Dr.P. Nammalwar Dr.M. Rajagopalan	Inception Workshop for GOI/UNDP/GEF Project for preparation of strategies for strengthening the Management of Gulf of Mannar Marine Biosphere Reserve at MSSRF, Chennai	October 9, 1997
Shri K. Dorairaj Dr. R. Paul Raj Dr. P. Nammalwar Dr.M. Vijayakumaran	Inaugural function on Impact Assessment of Aquaculture Enterprises - Rajeev Gandhi Centre for Aquaculture at Chennai	December 10, 1997
Shri K. Dorairaj Dr. M. Rajagopalan	Workshop on Coastal Bio- diversity of GOMMBR at MSSRF Chennai	February 10, 1998
Dr. R. Paul Raj Sr. Scientist	Biodiversity Conservation prioritisation programme Coastal Areas working Group Meeting, M.S. Swaminathan Research Foundation, Chennai	May 9, 1997
	National Agricultural Tech- nology Project Finetuning Workshop organised by ICAR and World Bank Consultant Dr. Peter Smith at CIFT, Kochi	May 1997
	NATP Workshop on project formulation and finalisation CMFRI, Kochi	July 1997
	National Workshop on Fish and Prawn Feeds, organised by the Central Institute of of Freshwater Aquaculture at Bhubaneswar and chaired the session on Research - Industry Interaction.	September 2-3, 1997

	NATP Orientation Workshop organised by ICAR at Chennai	October 1997
	Biodiversity Conservation prioritisation Programme Workshop - 111, M.S. Swaminathan Research Foundation Chennai.	November 14-15, 1997
Dr. R. Paul Raj M. Vijayakumaran	Colloquium on key issues relating to the fisheries MPEDA at Cochin	October 14-15, 1997 sector organised by the
	Workshop on Environmental Impact Assessment of Aquaculture enterprises organised by MPEDA at Chennai	December 10-12, 1997
Dr. R. Paul Raj M. Rajagopalan	National Workshop on New Economic Policy opportu- nities and challenges for sustainable development of fisheries and conservation of aquatic resources, Bhopal.	December 15-16, 1997
Dr. P. Nammalwar Sr. Scientist	Workshop on Conservation, Assessment and Management plan for Indian mangroves at NIO, Goa	July 21-25, 1997
Dr. P. Nammalwar Dr. M. Vijayakumaran	Indo-Egyptian Workshop on Oceanography organised by CMFRI at Kochi	December 8-9, 1997
Dr. M. Vijayakumaran Sr. Scientist	Workshop on problems and prospects of Export of living marine products organised by MPEDA at Chennai	May 15-16, 1997
	Meeting on fish quarantine procedures for import and export of fish germplasm organised by National Bureau of Fish Genetic Resources at CIFA, Bhubaneswar	July 30, 1997
	National Workshop on fish and shellfish health management organised by the Central Institute of Freshwater Aquaculture at Bhubaneswar	November 18-19, 1997
Dr. M. Rajagopalan Sr. Scientist	Workshop on Turtle Excluder organised by the MPEDA (India) in association with NMFS (USA) at Cochin	May 5-6, 1997



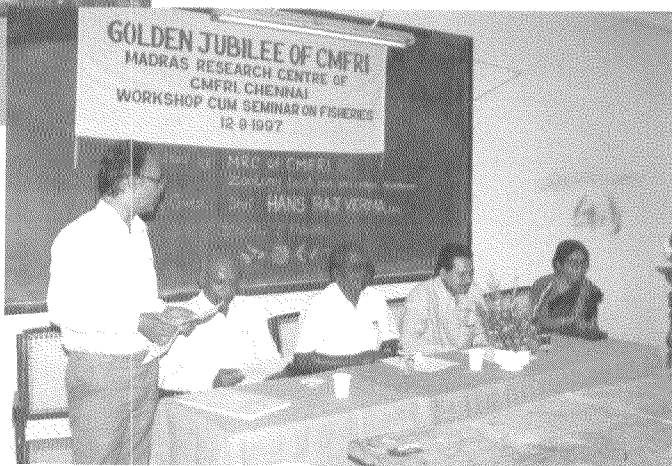
Inauguration of Golden Jubilee
 celebrations of CMFRI:
 Dr. K. Gopakumar, Director CIFT
 (Presently DDG Fisheries ICAR)
 speaking at the Function.
 Shri T.K. Ramakrishnan, Hon'ble
 Minister for Fisheries Govt.
 of Kerala and Dr. M. Devaraj,
 Director CMFRI on the dias.

View of the audience at the
 Inaugural function of Golden
 Jubilee celebrations of CMFRI



Distinguished participants
 along with the Director at the
 seminar on marine Fisheries
 and Mariculture at
 CMFRI, Cochin

Shri K. Dorairaj, Officer-in-
 charge, Chennai research
 centre of CMFRI speaking
 at the workshop cum seminar
 on fisheries at Chennai





Inaugural Address by Dr. (Mrs) Vasanthi Devi, Vice-Chancellor Manonmaniam Sundaranar University, in the Seminar on Recent developments in pearl culture, Grouper and crab farming

Delegates from Egypt and the Director CMFRI at the workshop on Mariculture and Oceanography in CMFRI Cochin



Dr. Kuber Vidyasagar officer-in-charge, Bombay Research Centre, Speaking on the achievements of CMFRI at the Fisherfolk meet at Bombay

CMFRI team of SCUBA divers engaged in inspection of submarine effluent pipeline of M/s. MRPL under the contract research at Mangalore



WORKSHOPS, SEMINARS, SUMMER INSTITUTES, FARMERS' MEET ORGANISED BY THE INSTITUTE

1. Indo-Egyptian Workshop on 'Oceanography with Exclusive Focus on Mariculture on 8th & 9th December 1997, Cochin.
 - Seafarming technologies
 - Fish culture
2. Zonal Workshop of Survey staff of FRAD Division working in Tamil Nadu, Pondicherry and those in Andhra Pradesh under Madras Jurisdiction, at Tuticorin Research Centre of CMFRI, Tuticorin from 24th to 27th September 1997.
 - Mussel farming
 - Crab farming
 - Prawn farming
 - Crab culture
 - Mycotoxin in feeds
3. Seminar on propagation of the mariculture technologies developed by CMFR Institute on 23-1-1998.
4. National Aquaculture Week Workshop/Trade Fair/Open House/Counselling organised by the Aquaculture Foundation of India, Chennai during 5-6 February 1997 at the Regional Centre of CMFRI, Mandapam Camp.
5. Seminar on "Recent Developments in Pearl culture, Grouper and Crab Farming" at the Regional Centre, Mandapam Camp during 6-7 February, 1998.
6. Zonal Workshop of the survey staff of CMFRI posted in the States of Maharashtra and Gujarat, at Mumbai Research Centre from 24 September to 27 September 1997.
7. 'Need for Research and Management in Fisheries' Fisherfolk Meet, Bombay Research Centre of CMFRI, Bombay on 21.1.1998
8. Fishermen/fish farmers counselling on Mussel culture and edible oyster culture was conducted at Pulicat on 28-4-1997.

In the year 1997-98 monthly fishermen-farmers-industry-institution meets and fishermen awareness campaign were conducted on the following subjects:

The meets were organised by the Regional and Research Centres of CMFRI. Most of the meets were conducted in the villages. The technology relevant to a village is selected and the details are presented by the concerned scientists in local languages. Package of practices of the culture technologies was explained to fisherfolk. The meetings were organised in a very informal way. Each meeting had a discussion/question-answer session in which the farmers freely interact with the scientists. The discussion was very informative to the fisherfolk. The meet was well attended by fishermen, farmers, industries and various institutions. Fisherfolk have shown a lot of interest in adopting the culture technologies. At the Bombay Research Centre, the monthly meet has created a revolutionary impact among the fisherman community. The meets are conducted every month.

The Research Centres of the Institute at Madras, Visakhapatnam and Kakinada are providing consultancy and technical guidance on onshore pearl culture effectively to the entrepreneurs.

Technical support in the culture of mussel at Calicut Research Centre and pearl culture at Tuticorin and Mandapam Camp is regularly provided to the fish farmers/industry.

DISTINGUISHED VISITORS**Cochin**

Shri C.K. Neelakanta Raj, Secretary, Dept. of Animal Husbandry and Fisheries, Govt. of Karnataka, Bangalore

Shri S.K. Mathur, Ambassador of India to Federal Republic of Yugoslavia

Prof. Milton Fingerman, Tulane University, New Orleans, USA

Dr. Natali Daanler, Australian Centre for International Agricultural Research

Dr. R.S. Paroda, Director General, ICAR and Secretary, DARE, New Delhi

Dr. A.K. Bandyopadhyaya, Director, CARI, Port Blair

Shri K. Roy Paul, Addl. Secretary, Ministry of Environment & Forests, New Delhi

Dr. Rob Lewis, Chief Executive, South Australian Research and Development Institute (SARDI), Australia

Dr. John Keesing Chief Scientist, SARDI, Australia

Dr. Martin Kumar, Sr. Scientist, SARDI, Australia

Dr. Soliman Hamed Abdel Rahim, NIO&F, Alexandria, Egypt

Dr. Fatima Ali, NIO&F, Alexandria, Egypt

Dr. Meseda Mohamed El-Gharabawy, NIO&F, Alexandria, Egypt

Dr. Hosny Ibrahim Emara, NIO&F, Alexandria, Egypt

Dr. G.R.M. Rao, Director, Central Institute of Brackishwater Aquaculture, Madras

Dr. R.K. Samantha, Zonal Coordinator, NDRI Campus, Bangalore

Dr. R.S. Reddy, Professor of Zoology, Madras Christian College, Tambaram

Dr. S.M. Zofair, College of Fisheries, Gujarat Agriculture University, Veraval

Dr. M. Aslam, Director, Department of Agricultural Research and Education, New Delhi

Dr. P. Marto Subroto, FAO, Rome, Asia-Pacific Fisheries Commission

Dr. R.C. Maheswari, Assistant Director General (CSC), ICAR, New Delhi

Dr. A. Venkataraman, Former Vice-Chancellor, Tamil Nadu Agricultural University, Madras

Dr. P.N. Jha, Ex Vice-Chancellor, Rajendra Agricultural University, Pusa, Samastipur

Dr. I.S. Yadav, Director, Indian Institute of Horticulture Research, Bangalore

Shri Shatrugan Prasad Singh, 24 MLA Quarters, Patel Path, Patna.

Dr. Asim Bala, Member of Parliament, Entally Govt. Housing Estate, Calcutta

Dr. P. Rethinam, Director, National Research Centre for Oil Palm, Eluru, A.P.

Dr. K. Pradhan, Vice-Chancellor, Orissa University of Agriculture & Technology, Bhubaneswar

Shri B.K. Chauhan, Secretary, Indian Council of Agricultural Research Krishi Bhavan, New Delhi

Shri Oscar Fernandes, Member of Parliament, Doris Rest Havem, Ambalpadu-Udupi, Karnataka

Dr. S.A.H. Abidi, Director, Central Institute of Fisheries Education, Mumbai.

Vizhinjam

Shri Raju Narayanaswamy, IAS, Govt. of Kerala

Shri J.C.V. Rene, Fisheries Resource Economist, BOBP (FAO), Madras



The Director General ICAR along with DDG (FY) and ADG (FY) on his visit to the CMFRI Residential quarters under construction at Cochin



Dr. R. S. Paroda, Director General ICAR on a cruise in the Exploratory fishing Vessel off Cochin



Egypt delegates visit the mussel farm at Padanne

Dr. R.S. Paroda, D.G. ICAR
declaring open the Field
Mariculture laboratory of
CMFRI on 18-7-97



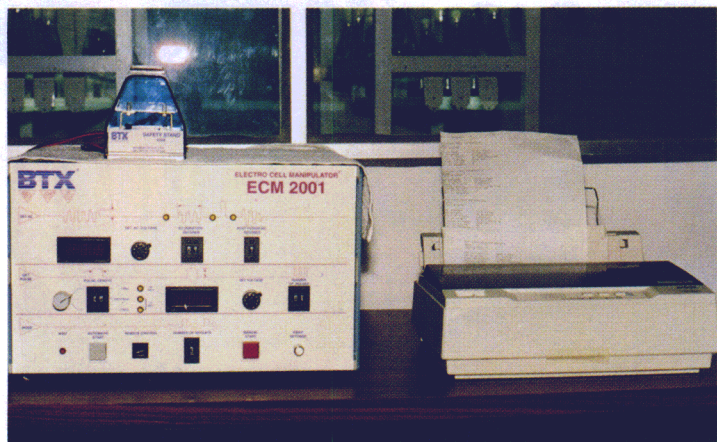
Dr. R.S. Paroda, D.G. ICAR
at the Field Mariculture
laboratory of CMFRI at Cochin



Pearl oyster hatchery at
Mandapam (being developed)



Cell Fusion System- Recently
acquired under DBT project for
Tissue culture programmes.



Dr. Rob Lewis, Chief Executive, South Australian Research and Development Institute (SARDI), Australia

Dr. John Keesing Chief Scientist, SARDI, Australia

Dr. Martin Kumar, Sr. Scientist, SARDI, Australia

Shri C. Chandran, IAS, Secretary, Govt. of Kerala

Justice S.M. Sidickk, Judge, High Court, Madras

Dr. Asim Bala M.P., Member, ICAR Governing Body, New Delhi

Shri M. Narasimha Rao, NAARM, Hyderabad

Shri M.K.K. Nair, Secretary, Staff side, CJSC, ICAR

Shri A.H. Nandgave, Asst. Engineer, MSEB, Nagpur

Dr. K.R. Gupta, Director, DST, New Delhi

Prof. C. Leelanandam, Osmania University

Dr. Soliman Hamed Abdel Rahim, NIO&F, Alexandria, Egypt

Dr. Fatima Ali, NIO&F, Alexandria, Egypt

Dr. Meseda Mohamed El-Gharabawy, NIO&F, Alexandria, Egypt

Dr. Hosny Ibrahim Emara, NIO&F, Alexandria, Egypt

Dr. D.M. Thampy, College of Fisheries, Panangad, Cochin

Dr. K. Ravindran, Director, CIFT, Cochin

Dr. Ram Babu, Head of Division of Eco. & P.P., CSWCRTI, Dehra Dun

Dr. D. Sudarsan, Director General FSI (Retd)

Prof. N. Balakrishnan Nair, Chairman, Research Advisory Committee of CMFRI

Shri A.P. Bernard, P.A. to A.M. & President of ICAR, Krishi Bhavan, New Delhi

Dr. A.E. Muthunayagam, Secretary, Department of Ocean Development, New Delhi

Dr. P.V. Dehadrai, ICAR, New Delhi

Dr. Y.S. Chauhan, Sr. Scientist, NIO, Goa

Shri S.K. Mathur, IAS, Dy. Secretary, Ministry of Environment, New Delhi

Dr. A.G. Ponniah, Director, NBFGR, Lucknow

Prof. D. Venkata Rao, Dept. of Pharmaceutical Sciences, Andhra University, Visakhapatnam

Shri A.S. Bhatia, Under Secretary (Fy.), ICAR, New Delhi

Shri Rattan Prakash, CP & PRO, ICAR, New Delhi

Dr. M. Peter Marian, M.S. University, S.C. College Campus, Nagercoil

Shri Vidyarthi Samier, Executive Director, EBI Culture (I) Ltd., Malad, Bombay

Shri Prabh Das, Director, Dept. of Ocean Development, New Delhi

Shri R. Sarin, Joint Secretary, Dept. of Ocean Development, New Delhi

Veraval

Dr. A.K. Pandey, Scientist (SS), NBFGR, Lucknow

Dr. G. Ragothaman, Head, Deptt. of Aquatic Biology, South Gujarat University, Surat

Dr. A.V.R.L. Narasimhachary, Deptt. of Bio-Science, Sardar Patel University, Vallabh Vidyanagar

Mr. H.K. Moor, MRH Food Processing Co., Malaysia

Tuticorin

Dr. Rob Lewis, Chief Executive, South Australian Research and Development Institute (SARDI), Australia

Dr. John Keesing Chief Scientist, SARDI, Australia

Dr. Martin Kumar, Sr. Scientist, SARDI, Australia

Dr. Soliman Hamed Abdel Rahim, NIO&F, Alexandria, Egypt

Dr. Fatima Ali, NIO&F, Alexandria, Egypt

Dr. Meseda Mohamed El-Gharabawy, NIO&F, Alexandria, Egypt

Dr. Hosny Ibrahim Emara, NIO&F, Alexandria, Egypt

Mr. Hussain Zahir, Research Officer, Ministry of Fish and Agriculture, Republic of Maldives.

Dr. V. Ravindranathan, Director, DOD, Kochi

Dr. P. Ramanathan, Registrar, Manonmaniam Sundaranar University, Tirunelveli.

Dr. V.S. Rao Chintala, Director, DOD, New Delhi

Dr. K.V.K. Nair, SO(SG) & Programme Leader, Marine Biology Programme, WSCL, ICAR, Kalpakam

Dr. A.N.P. Ummerkutty, Former Vice Chancellor, Calicut University,

Shri G. Pati, Scientific Officer, HWP., P.O. Vikrampur, Orissa

Calicut

Dr. Rob Lewis, Chief Executive, South Australian Research and Development Institute (SARDI), Australia

Dr. John Keesing Chief Scientist, SARDI, Australia

Dr. Martin Kumar, Sr. Scientist, SARDI, Australia

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Dr. Fatima Ali, NIO&F, Alexandria, Egypt

Dr. Meseda Mohamed El-Gharabawy, NIO&F, Alexandria, Egypt

Dr. Hosny Ibrahim Emara, NIO&F, Alexandria, Egypt

Kakinada

Shri C.K. Sajeer and K.R.S. Patnaik along with 23 trainees of D.F.Sc. 36th batch from CIFE, Mumbai

Dr. Md. Azar Baig, Government Degree College, Puttur in Chittoor District, A.P. alongwith 16 students of Final B.Sc. (Aquaculture)

Mrs. Sujani Sri Ram, Lecturer in Fisheries, Andhra Loyola College, Vijayawada

Visakhapatnam

Shri R.P. Raman, Scientist, Regional Centre of CIFE, Kakinada

Prof. Milton Fingerman, Tulane University, New Orleans, U.S.A.

Prof. Jeffrey Morrel, Oregon State University Corvallis, Oregon, U.S.A.

Dr. P. Sitarami Reddy, Professor of Zoology, Madras Christian College, Chennai

Dr. C. Raja Reddy, Director of Research, Acharya N.G. Ranga Agricultural University, Hyderabad

Mandapam

Mr. Kasirajan, I.A.S., District Collector, Madurai.

Dr. G. Subramanian, Director, N F M C, & party, Bharathidasan University, Trichy.

Shri. N. Renganathan, P/B Officer, Press Information Bureau, Madras.

Mr. R.N. Ganesh, Vice-Admiral, DG Coast Guard.

Dr. S.D. Gomkalae, Acting Director, CMSCRI (CSIR), Bhavanagar

Dr. D.K. Sharma, I.P.S., 2/116, Vishwas Khand, Gandhi Nagar, Lucknow

Mr. Hussian Zahi, Research Officer, Marine Research Section, Ministry of Fisheries, Republic of Maldives & Agriculture, Male.

Mr. Mohammed Jameel, Male

Mr. Munawar Mohammed, Male.

LN. Sutagar, Dy. Director, Natl. Adventure Instt., Pachmarhi, Madya Pradesh

Mr. R.P.S.Katwal, Chief Wildlife Warden, Chennai

Dr. Rob Lewis, Chief Executive, South Australian Research and Development Institute (SARDI), Australia

Dr. John Keesing Chief Scientist, SARDI, Australia

Dr. Martin Kumar, Sr. Scientist, SARDI, Australia

Jason Rubens, World Conservation Union (IUCN), 7, Vajira Lane, Colombo 5, Sri Lanka.

Ratan Prakash, Chief P R O, I C A R, New Delhi.

Comdt. S.P.Sharma, Jt. Director (OPS), C G H.Q, New Delhi.

Vinneta Hoon, M.S. Swaminathan Res. Foundation, 3rd Cross street, Taramani Institutional Area, Chennai

Dr. Mrs. Vijayavalli, Dy. Director, C E C R I, Karaikudi.

Prof. Graeme Keller, Great Barrier Reef Authority, Australia.

Dr. Soliman Hamed Abdel Rahim, NIO&F, Alexandria, Egypt

Dr. Fatima Ali, NIO&F, Alexandria, Egypt

Dr. Meseda Mohamed El-Gharabawy, NIO&F, Alexandria, Egypt

Dr. Hosny Ibrahim Emara, NIO&F, Alexandria, Egypt

Mr. C.P. Oberai, I G Forests, Spl. Secretary to GOI, New Delhi.

Dr. A.K. Kumaraguru, School of Energy, Environment & Natural Resources, M.K. University, Madurai

Mr. S. Ramadas, ADC to Governor (Retd)., Plot 1031-5200, K.K. Nagar, Madras 78.

Group Captain, S. B Prasuer, C.O. & BRD AF, Avadi, Madras

Dr. V.A. Satya Prema, Head, Dept. of Zoology, Govt. Arts College, Nandanam, Chennai

Dr.(Mrs) Vasanthi Devi, Vice Chancellor, M.S. University, Abishekapatti, Tirunelveli.

Bombay

Dr.S.K.Alam, Reader in Zoology, Mumbai University, Mumbai with 33 students.

Dr. (Mrs) S.A.Gaikwad, Reader Zoology, Mumbai University, Mumbai.

Mr. K.A. Dongre, Dy. Director Fisheries along with 12 Asstt. Fisheries Development Officers of the Fisheries Department, Maharashtra.

Er N.L. Gurjar, Member of the Management Committee C.M.F.R.I. Cochin

Ms. Sameera Khan, Junior Assistant Editor, Times of India

Ms. Jyoti Shahpurkar, Correspondent of In Time, TV News, Indusind Media and Communications Limited

Mangalore

Shri. V.Hariharan, Prof. & Head of Department, Fishery Oceanography, College of Fisheries, Mangalore.

Shri J. Prasad, Hindustan Lever Ltd., Gujarat.

Shri P.M.Das, White Fish Infor. Pvt. Ltd., Madhur, Door No. 24/1/49/2, Vaidyanath Nagar, Attawar, Mangalore.

Dr. X.N.Verlecar, Dr. V.K.Dherjalkar, Shri R.A. Sripada, NIO, Dona Paula, Goa.

V. Srinivasan, Chief General Manager, NABARD, Bangalore

Shri R.K.Singh, Dy. Conservator of Forests (Wild Life), Karkala

Shri Jason Keith, Shri Shraddha C., Smt. Anna Poorna O., Shri Sudhir K., National Law School of India University, P.B.7201, Nagarabhavi, Bangalore

Shri H.C.Madan Kumar, Statistical Inspector, Directorate of Fisheries, Bangalore

Shri Mahesh Kumar U., Extension Officer,
S.K.CO.OP.Fish Marketing Federation, Mulihithlu,
Mangalore

Shri P. Parashuram, President, S.K.District Co-Op. Fish
Marketing Federation, Mangalore

Shri. T.Kagaya, Kagaya co. Ltd., Bangalore

Dr. D.S.Sheshappa, Prof. & Head, Dept., of Fishery
Engineering, College of Fisheries, Hoige Bazar,
Mangalore

Shri J.A.Hussain, Vice Chairman, Bird Life International
and President Biodiversity Initiative Trust, Mangalore

Dr. P. Keshavanath, Prof. & Head, Dept. of Aquaculture,
College of Fisheries, Hoige Bazar, Mangalore.

Madras

Dr. P.V. Dehadrai, Dy. Director General (Fisheries) ICAR,
New Delhi.

Dr. A.K. Bandyopadhyay, Director, CARI, Port Blair

Dr. M. Sakthivel, President, A.F.I., Chennai

Dr. Kee-Chai Chong, BOBP/FAO, Chennai

Cap. C.M. Karnaker, President, Alphamain Canada
Ltd., Canada.

Dr. Sumet Eaungpulsawat, General Manager, C.P. Inter-
trade Co.Ltd., Thailand

Dr. Jennifer Nichol, South Asia Development Planning
Inc., New Delhi.

Dr. G.R.M. Rao, Director, CIBA, Chennai

Shri Venkatesan, Director, MPEDA, Kochi

Dr. R. A. Selva Kumar, Asst. Director General, ICAR,
New Delhi

Dr. Rajeswari Anand, Biodiversity Consultant, MSSRF,
Chennai.

Dr. Honsy Ibrahim Emara, Dr. Soliman H. Abdul
Rahman, Dr. (Mrs) Fatima Aly Abdul Razak and
Dr. (Mrs.) Meseda, National Institute of Oceanography
and Fisheries, Alexandria.

Dr. Randhir Singh, Scientist, CIFE, Mumbai along with
22 Fisheries Officer Trainees.

PERSONNEL (MANAGERIAL POSITIONS ONLY)

- | | | |
|--|---|---|
| 1. Director | - | Dr. M. Devaraj |
| 2. Heads of Divisions | | |
| Fishery Resources Assessment Division | - | Shri K. Narayana Kurup
Sr. Scientist |
| Pelagic Fisheries Division | - | Dr. N. Gopalakrishna Pillai |
| Demersal Fisheries Division | - | Dr. V. Sriramachandra Murty |
| Crustacean Fisheries Division | - | Dr. G. Sudhakara Rao |
| Molluscan Fisheries Division | - | Dr. K.K. Appukuttan |
| Fishery Environment Management Division | - | Dr. V. Narayana Pillai |
| Physiology, Nutrition and Pathology Division | - | Dr. M. Peer Mohamed
Principal Scientist |
| Socio-Economic Evaluation & Technology Transfer Division | - | Dr. R. Sathiadhas
Sr. Scientist |
| 3. Sr. Administrative Officer | - | Shri P. Bapaiah |
| 4. Sr. Finance & Accounts Officer | - | Shri A.V. Joseph |
| 5. Administrative Officer | - | Shri P.S. Sudersanan |
| 6. Officers-in-Charge of Regional/ Research Centres | | |
| Mandapam Camp | - | Dr. A.C.C. Victor
Sr. Scientist |
| Madras | - | Shri K. Dorairaj
Principal Scientist |
| Tuticorin | - | Shri D.C.V. Easterson
Sr. Scientist |
| Kakinada | - | Shri G. Subbaraju
Principal Scientist
(up to 28.2.1998) |
| | - | Dr. H. Mohamed Kasim
Sr. Scientist
(from 28.2.1998) |
| Karwar | - | Dr. V.S. Kakati
Sr. Scientist |

Mangalore	-	Dr. C. Muthiah Sr. Scientist
Veraval	-	Shri B. Manojkumar Scientist
Vizhinjam	-	Dr. P.A. Thomas Sr. Scientist (up to 4.3.1998)
	-	Shri K. Prabhakaran Nair Sr. Scientist (from 5.3.1998)
Bombay	-	Dr. Kuber Vidyasagar Sr. Scientist
Minicoy	-	Shri M. Sivadas Scientist (S S)
Visakhapatnam	-	Dr. V.S.K. Chennubhotla Principal Scientist
Calicut	-	Dr. P.S. Kuriakose Principal Scientist
Krishi Vigyan Kendra	-	Shri K.P. Said Koya, Scientist (SS)
Trainers' Training Centre	-	Dr. V. Kunjukrishna Pillai Sr. Scientist
Fisheries Harbour Laboratory	-	Shri P.E. Sampson Manickam Sr. Scientist

SPECIAL INFRASTRUCTURAL DEVELOPMENT

Special efforts to speed up the construction/development of infrastructure facilities for the Institute have been made. The Kerala State Nirmithi Kendra was entrusted with the construction of multi-purpose aquaculture complexes at Cochin and Calicut, work is expected to complete within 3-4 months. A modern multipurpose aquaculture complex was constructed at Calicut by modification of an existing building; the complex has facilities for conducting advanced research on breeding and hatchery production of seeds of fishes, crustaceans and molluscs. The main features are a 200-tonne capacity seawater storage sump, 6 numbers of 10-tonne capacity grow out tanks, 5 numbers of 5-tonne capacity larval rearing tanks, 6 nos. of 10-tonne capacity

nursery rearing tanks, 2 nos. of 10-tonne capacity broodstock tanks, and area for mass culture of live feed organisms. The complex has air-conditioned laboratory for stock culture of microalgae, a modern biotechnology laboratory, conference hall, and a library.

The construction of residential quarters at Cochin is being completed

Permanent PVC pipeline for pumping seawater is established at FHL, Cochin.

6 Nos. of translucent FRP tanks each of 300 L. capacity are established for outdoor/indoor, mass backup batch algal culture system established at FHL, Cochin.